2006 Building Code Technical Training Courses

Resource Conservation All Buildings – 2006

Participant's Manual

Building and Development Branch
Ministry of Municipal Affairs & Housing

Ontario

Ontario

2006 Building Code
Technical Training Courses

Resource Conservation All Buildings - 2006

PARTICIPANT'S MANUAL

This course was developed by **Morrison Hershfield Limited**

for the **Ontario Ministry of Municipal Affairs and Housing.**

The course is based on the Ontario Building Code 2006 (O. Reg. 350/06), as amended.

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INTRODUCTION

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INTRODUCTION

Welcome! Over the next two days, you will be concentrating on the requirements of resource conservation set out in Part 12 of the 2006 Building Code.

The course has been designed to give you an understanding of the Code requirements applicable to resource conservation for all buildings, including Part 9 residential, Part 9 non-residential, and Part 3 buildings.

Every effort has been made to cover as much of the Part 12 content as possible. However, participants should consult Division B, Part 12 of the Code to become familiar with all subject matter.

RESOURCES

There are many resources that will assist you in this course, including:

- Your experience as a plan examiner, inspector, or designer
- The experience of others in the class
- The 2006 Building Code and Building Code Act
- Exercises that ask you to understand why the regulations exist and to relate your experience to the information presented
- This workbook. This is your book, and you are encouraged to record answers and write notes in it. It should be a useful reference when you are back on the job.

The resources you will require for the class are this workbook and a 2006 Building Code (Volumes 1 and 2).

These documents are available from: www.publications.serviceontario.ca

The following resource materials are optional and may be of use in your regular work:

- NRCan "EnerGuide for New Houses: Administrative and Technical Procedures"
- ANSI/ASHRAE/IESNA 90.1-2004 "Energy Standard for Buildings Except Low-Rise Residential Buildings"
- The 1997 edition of the "Model National Energy Code for Buildings 1997" (MNECB)
- SMACNA "HVAC Duct Construction Standards – Metal and Flexible, 1995 2nd Edition"

A calculator, a highlighter and some sticky notes may help you mark key tables and requirements.

MEET YOUR GROUP

Before you start into the course materials, it is important for you to meet the people you will be working with during this course. You have had a variety of experiences as a Building Code practitioner, which you can share with the class; similarly, they have had experiences that they can share with you.

EXERCISE 1

Take a few minutes and introduce yourself to your group. Let them known where you're from, and your background. Listen carefully to the types of job experiences that other members of your group have had. They will be useful in completing exercises later on in this course.

Name	Employer and Job Title	Responsibilities

STOP

THE MUNICIPALITY/REGION

Building plan examinations and inspections take place in the context of the municipality or the region. The types of services offered by the municipality or region have an impact on your role as a building plan examiner or inspector.

EXERCISE 2

Who, in your group, wears more than one hat (or role), and what are they? These people bring a different perspective to a building inspection problem.

Name **"Hats"**

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STOP

ROLES OF THE PLANS EXAMINER, BUILDING INSPECTOR, AND DESIGNER

Regardless of the other hats you may wear, you have a very important job as a plans examiner and building inspector. Your role is to ensure the health and safety of residents in your community by:

- Providing information - technical knowledge and information about the appropriate legislation - to contractors, the public and your Council.
- Examining the building under your jurisdiction to ensure they comply with regulations.
- Applying, interpreting, administering and enforcing the requirements.
- Employing all your technical and personal skills to gain voluntary compliance with the Code.
- Co-operating with other building officials in the interests of the public.

Being a plans examiner or inspector calls for a combination of technical knowledge and an ability to deal with the public. Technical problems can usually be dealt with fairly easily; but dealing with the public requires tack and good judgement.

YOUR EXPECTATIONS FOR THIS COURSE

EXERCISE 3

Consulting the course Table of Contents, consider what do you expect to learn from this course?

In your group, discuss this question and write your objectives on your group flip chart. After your group discussion, you'll be sharing these objectives with the rest of the class.

At the end of the course, you will assess how well these expectations have been achieved - so make sure you write them down.

STOP

FORMAL COURSE OBJECTIVES

This course has some specific objectives in mind. See how closely they match your own.

Upon completion of this course, you will be able to:

- Find Code requirements that govern resource conservation
- Identify different compliance options for energy efficient design for Part 9 residential buildings
- Identify different compliance options for energy efficient design for Part 9 non-residential buildings
- Identify different compliance options for energy efficient design for Part 3 buildings
- Recognize the transition dates for energy efficient designs
- Identify additional requirements that are used mutually dependant with all compliance options.

COURSE FORMAT

Before you go on to accomplish these objectives, spend a few minutes acquainting yourself with the format of this course.

The course consists of 9 modules, ranging in length from 15 minutes to a few hours.

Each module deals with a particular topic and builds on information presented in previous modules. This logical sequence makes it easier to remember what you've learned, as you progress.

Each module outlines the learning objectives of the module, and has examples and exercises such that you can see how well you are doing.

You have already encountered one type of exercise that will occur frequently throughout the course - the group discussion. This is probably the most valuable part of the course, as you share your knowledge and experience with your group and learn from them.

A variety of materials will be used to help you learn, such as overheads, diagrams and individual or group exercises.

THE FACILITATOR

An important person in this course is your facilitator. The facilitator is not here to lecture, but to guide your discussions, provide examples from experience, and mediate discussions.

Your facilitator is experienced in resource conservation and can offer valuable hints from years of experience. Don't expect the facilitator to have all the answers - no one does - but he or she can provide guidance for your search for the answers.

STOP

THE OBJECTIVE-BASED CODE FORMAT

The 2006 Building Code is published in an "Objective-Based" format. The Objective-Based format adds to the technical requirements by identifying the underlying objectives and sub-objectives of those requirements. Each technical requirement that is an acceptable solution in Division B is linked to one or more objectives, as well as functional statements.

The Objective-Based format is intended to assist Code users in understanding technical requirements, why they exist and what they are intended to achieve. The Objective-Based Code establishes a framework for evaluating "alternative solutions" against the performance achieved by "acceptable solutions" set out in the Code.

This course is prepared to discuss the Part 12 Resource Conservation provisions in the 2006 Building Code. Training related to the Objective-Based format, and how to deal with alternative solutions is not part of this course.

A few key points about the Objective-Based Code are below.

The organization of the 2006 Code is:

Division A **Compliance, Objectives and Functional Statements**

The new objectives and functional statements are in Division A. Definitions and the application of the Parts of the Code are here.

Division B **Acceptable Solutions**

This is where the technical requirements of the 2006 Code are located.

Division C **Administrative Provisions**

This Division deals with permits, inspections and qualifications.

Remember that the full reference for Part 12 Resource Conservation is "Division B, Part 12 Resource Conservation". Always specify the appropriate Division if there is any chance of confusion. Where the Division is not referenced within this course, it is Division B.

STOP

A GUIDE TO THE USE OF THE BUILDING CODE

The decimal numbering system of the previous Code is maintained within Divisions A, B and C of the 2006 Code.

The first number indicates the Part of the Division, the second, the Section in the Part, the third, the Subsection and the fourth, the Article in the Subsection. An Article may be further broken down into Sentences (indicated by numbers in brackets), and the Sentence further divided into Clauses, Subclauses, Sub-subclauses, and Paragraphs.

These are illustrated as follows:

12	Part
12.3.	Section
12.3.4.	Subsection
12.3.4.5.	Article
12.3.4.5.(5)	Sentence
12.3.4.5.(5)(a)	Clause
12.3.4.5.(5)(a)(i)	Subclause
12.3.4.5.(5)(a)(i)(A)	Sub-subclause
12.3.4.5.(6).1.	Paragraph

Defined Words, Terms and Phrases

Words, terms and phrases with special meaning are defined in Division A, Clause 1.4.1.2.(1)(b) of the Building Code, and are shown within the body of the Code in *italics*. The definition always applies unless the word, term or phrase has a special purpose definition listed elsewhere.

Non-Defined Words, Terms and Phrases

Consult Division A, Sentence 1.4.1.1.(1) of the Building Code. It provides direction for dealing with non-defined terms. Note any questions, comments, or concerns in the space provided.

Abbreviations and Symbols and Referenced Documents

The Building Code uses abbreviations and symbols throughout. Their meaning is found in Division A, Subsection 1.4.2.

For example, the abbreviation RSI means thermal resistance, International System of Units.

Abbreviations for organizations and associations (proper names) are found in Table 1.3.2.1. in Division B. For example, ASHRAE means American Society of Heating, Refrigerating and Air-Conditioning Engineers.

All documents referenced in the Code are found in Part 1, Division B, Table 1.3.2.1.

STOP

BASIC RULES FOR READING THE CODE

Scope and Application of Code Requirements

Individual requirements within the Code do not apply to every *building*. Guidance in the application of each of the 12 Parts of Division B is found in Division A, Subsection 1.1.2.

For this course, it is important to know that Part 12 of Division B applies to all buildings, however not all provisions included in Part 12 apply to all buildings. Some Subsections are only applicable to Part 9 residential buildings, others only apply to Part 9 non-residential.

Dealing with 'And'

The word '**and**' found at the end of the second last Clause of a Sentence with multiple Clauses means that the requirements of **<u>every</u>** Clause apply to the Sentence.

For example, Division B, Sentence 12.2.1.1.(4) reads:

> *The energy efficiency of a building or part of a building may conform to the design requirements of Subsection 12.3.4. if the building or part of the building,*

(a) *is within the scope of Part 9,*

(b) *does not contain a residential occupancy,*

(c) *does not use electric space heating,* ***and***

(d) *is intended for occupancy on a continuing basis during the winter months.*

Dealing With 'Or'

The word '**or**' found at the end of the second last Clause of a Sentence with multiple Clauses means that the requirement of the Sentence is satisfied by **any** Clause as applied individually.

For example, Division B, Sentence 12.2.1.1.(3) reads:

The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,

(a) *Conform to the thermal insulation requirements of Subsection 12.3.2.,*

(b) *Conform to the thermal design requirements of Subsection 12.3.3.,* ***or***

(c) *Provide a rating of 80 or more when evaluated in accordance with NRCan "EnerGuide for New Houses: Administrative and Technical Procedures".*

Rules of the Building Code

The Code is structured into a number of Rules that apply without exception.

For example, Division B, Sentence 12.2.2.1.(3) states:

A motion sensor shall not be used to control emergency lighting.

General Rules of the Building Code and Exceptions

At other times, the user of the Building Code has to consider a general rule and exceptions that may be applicable.

Consider the application of energy efficiency for buildings within the scope of Part 9 given in Division B, Article 12.3.1.1.:

(1) Except as provided in Sentence (2), this Section applies to the energy efficiency of buildings within the scope of Part 9 intended for occupancy on a continuing basis during winter months.

(2) This Section does not apply to,

(a) Farm buildings, and

(b) *Buildings intended primarily for manufacturing or commercial or industrial processing.*

When the Code spells out a general rule and exceptions thereto, conformity with the Code is obtained by complying with EITHER the general rule OR the exception.

Tables, Text and Footnotes

Whenever you are called upon to use a Table in the Code, you have to consider the text associated with the Table **and** the footnotes.

For example, Division B Table 12.3.2.1.

- Forms part of Sentence 12.3.2.1.(4).
- Note (1) to Table 12.3.2.1. tells us to refer to the Supplementary Standard SB-1 (found in Volume 2 of the Code) when determining the number of degree-days for individual locations in Ontario.

Supplementary Standards and Referenced Documents

The Supplementary Standards, published as Volume 2 of the 2006 Building Code Compendium form an integral part of the 2006 Building Code.

Appendices

The Appendices to the 2006 Building Code, published in Volume 2, have been prepared for convenience only. This material contains explanations that do **not** form part of the Code and are **not** intended to limit the ways by which compliance with Code requirements can be achieved.

LIST OF ABBREVIATIONS

The following abbreviations are used in this course:

HVAC	Heating Ventilation and Air-Conditioning System
MNECB	Model National Energy Code for Buildings
E_t	Thermal efficiency of the boiler
RSI	Resistance System International, is a metric measure of the thermal resistance (or resistance to heat flow)
R-Value	The imperial measure of thermal resistance
U-Value	Thermal conductance, is a measurement of the ability of a material to conduct heat
HDD	Heating degree-days
Tavg	Average temperature
low-E	Low emissivity
ER	Energy rating
PVC	Polyvinyl chloride
BEF	Ballast efficacy factor

ANSWER GUIDE

An answer guide is included at the end of this workbook.

During the class please do not look at the answer guide unless instructed by the facilitator.

If you are working on your own, you are encouraged to try each exercise and quiz yourself before turning to look at the answers.

END

MODULE 1

APPLICATION OF PART 12
RESOURCE CONSERVATION

TABLE OF CONTENTS

INTRODUCTION

This module describes the general application of Part 12 Resource Conservation and the underlying objectives for energy efficient design in buildings. Each of the options for different building types are identified and the mandatory dates for transitioning to new provisions are identified. The application of the Supplementary Standard SB-10 "Energy Efficient Supplement" is also described.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the objectives and functional statements applicable to Part 12 Resource Conservation provisions
- Identify the different options for energy efficient design for residential buildings under Part 9
- Identify the different options for energy efficient design for Part 9 non-residential buildings (without electric space heating)
- Identify the different options for energy efficient design of all other buildings
- Identify the transition dates that will apply to changes to Part 12 for energy efficient design
- Recognize the application and content of SB-10 and other referenced Standards

READ TO THE NEXT STOP

APPLICATION OF PART 12

Division B, Part 12 applies to all buildings as required by Division A, Sentence 1.1.2.1.(1). In keeping with the general application of the Building Code, Part 12 applies to the design and *construction* of *buildings*. The terms *construction* and *building* are defined in the Building Code Act as follows:

'Construct' means:

> *to do anything in the erection, installation, extension or material alteration or repair of a building and includes the installation of a building unit fabricated or moved from elsewhere and "construction" has a corresponding meaning.*

'Building' means:

(a) *a structure occupying an area greater than ten square metres consisting of a wall, roof and floor or any of them or a structural system serving the function thereof including all plumbing, works, fixtures and service systems appurtenant thereto*

(b) *a structure occupying an area of ten square metres or less that contains plumbing, including the plumbing appurtenant thereto,*

(c) *plumbing not located in a structure*

(c.1) *a sewage system, or*

(d) *structures designated in the building code;*

Although Part 12 applies to all buildings, there are some "buildings" that will not be affected by the requirements for resource conservation.

COMPLETE THE NEXT EXERCISE

EXERCISE 1-1

From the definition of "building", identify examples of building types that may not need to be designed in conformance with Part 12 Resource Conservation.

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STOP

OBJECTIVES AND FUNCTIONAL STATEMENTS

Table 12 of Supplementary Standard SA-1 "Objectives and Functional Statements Attributed to the Acceptable Solutions" identifies all corresponding linked pairs of functional statements and objectives for each Part 12 provision.

Objectives

Most of the provisions of Part 12 are directly associated with the objective OR2 "Resource Conservation – Energy Conservation" as defined in Division A, Table 2.2.1.1.

> ***OR 2 Resource Conservation – Energy Conservation:*** *An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a natural resource will be exposed to an unacceptable risk of depletion or the capacity of the infrastructure supporting the use of the resource will be exposed to an unacceptable risk of being exceeded, caused by the consumption of energy.*

However, some of the provisions of Part 12 are associated directly with other objectives including:

- OS3.1 and OS3.7 "Safety – Safety in Use" for motion sensors to control lighting;
- OH1.1 and OH1.2 "Health – Indoor Conditions" for required insulation and air/vapour barrier;
- OS2.3 "Safety – Structural Safety" for required insulation and air/vapour barrier.

OR 1 Resource Conservation – Water Conservation is not directly referenced in Part 12, but is referenced in Subsection 7.6.4, which is referenced by Part 12. OR1 is applicable for the provisions associated with water conservation.

Functional Statements

Most of the provisions of Part 12 are linked to ***Functional Statement 131 "To limit excessive energy consumption"*** as listed within Division A, Table 3.2.1.1.

However, other functional statements also apply, including the following:

F10: "To facilitate the movement of persons to a safe place in an emergency" for motion sensors to control lighting

F30: "To minimize the risk of injury to persons as a result of tripping, slipping, falling, contact, drowning or collision" for motion sensors to control lighting

F50: "To provide air suitable for breathing" for ducts, plenums and piping

F51: "To maintain appropriate air and surface temperatures" for required insulation

F54: "To limit drafts" for air infiltration limitations

F55: "To resist the transfer of air through environmental separators" for air infiltration limitations

F63: "To limit moisture condensation" for required insulation

These functional statements are compatible with the provisions of Part 12 Resource Conservation and, with the objectives, identify the areas of performance for Code provisions.

Every requirement under Part 12 has a functional statement/objective linked pair, however, there are some Code provisions where more than one linked pair of objectives/functional statements apply. Each of these linked pairs must be considered if an alternative solution is being considered.

EXAMPLE

What is the linked pair of functional statement and objective corresponding to Sentence 12.2.1.1.(2)?

Division B, Sentence 12.2.1.1.(2)

Except as provided in Sentences (3) and (5) and permitted in Sentence (4), the energy efficiency of all buildings shall be designed to good engineering practice such as described in,

a) the ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings" and Supplementary Standard SB-10, or

(b) the Model National Energy Code for Buildings and Supplementary Standard SB-10.

Sentences 12.2.1.1.(3) specifically applies to Part 9 residential occupancies. Sentence 12.2.1.1.(3) includes the exceptions to the application of Sentence 12.2.1.1.(2).

Solution:

→ Refer to Table 12 in the Supplementary Standard SA-1

→ In column 1, locate the reference to 'acceptable solution' 12.2.1.1.(2)

→ The corresponding Objectives and Functional Statements are identified in column 2

→ One pair of objectives and functional statement is linked to Sentence 12.2.1.1.(2) F131-OR2

Functional Statement: F131

Objective: OR2

COMPLETE THE NEXT EXERCISE

EXERCISE 1-2

For the following Code provisions list the corresponding linked pairs of Objectives and Functional Statements.

Code Provision	Functional Statements and Objectives
Motion Sensors 12.2.2.1.(2)	______________________
	______________________
Air Infiltration 12.3.3.13.(2)	______________________
	______________________
	______________________
Thermal Resistance 12.3.3.3.(1)	______________________
Required Insulation 12.3.2.1.(2)	______________________
	______________________
	______________________
	______________________
	______________________
	______________________

STOP

SCOPE OF APPLICATION OF PART 12

Part 12 contains requirements for all buildings for the following resource conservation measures:

- Energy efficient design including
  - Provisions for energy efficient design of building envelopes (Modules 2, 3, 5)
  - Provisions for energy efficient windows and doors (Modules 2, 3, 6)
  - HVAC systems specifically for non-residential Part 9 buildings (Module 8)
  - Service water heating systems specifically for non-residential Part 9 buildings (Module 9)
  - Electric motors for non-residential Part 9 buildings (Module 10)
  - Lighting specifically for non-residential Part 9 buildings (Module 11)
- Motion sensors to control lighting (Module 12)
- Water efficiency (Module 13)

As per Division B, Sentences 12.2.1.1.(5) and 12.2.1.2.(5), energy efficient design does not apply to the following buildings:

- Farm buildings;
- Buildings intended primarily for manufacturing or commercial or industrial processing;
- Buildings **not** intended for occupancy on a continuing basis during the winter months;
- Exceptions identified in SB-10.

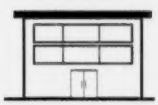
ENERGY EFFICIENT DESIGN OPTIONS AND TRANSITION DATES

The provisions for energy efficient design are described for two time periods. For applications for building permit submitted **up to December 31, 2011**, several options are provided for all building types. For applications for building permit **after December 31, 2011**, some of the options are no longer available.

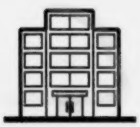
For each of the time periods, energy efficient design options are different for residential buildings within the scope of Part 9, non-residential buildings within the scope of Part 9 and all other buildings not in the scope of Part 9.

Throughout the course, building symbols have been included to help the participant recognize the application of the requirements. The following symbols have been used:

Provisions apply to **Part 9, Residential Buildings**



Provisions apply to **Part 9, Non-Residential Buildings** (without electric space heating)



Provisions apply to **all other buildings** (including Part 3 and Part 9 non-residential buildings with electric space heating)

Note: Provisions that apply to more than one building type will show all applicable symbols.

STOP

PART 9 RESIDENTIAL BUILDINGS, UP TO DECEMBER 31, 2011

Buildings of residential occupancy within the scope of Part 9 can follow any one of the **three possible options** for energy efficient design.

Sentence 12.2.1.1.(3) sets out the minimum requirements relative to energy efficiency for Part 9 residential buildings intended for occupancy on a continuing basis during winter months. Any <u>one</u> of the following provisions can be applied:

Division B, Sentence 12.2.1.1.(3)

(a) *...thermal insulation requirements of Subsection 12.3.2.*

(b) *...thermal design requirements of Subsection 12.3.3.*

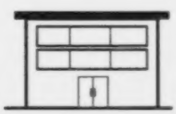
OR

(c) *Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures"*

PART 9 RESIDENTIAL BUILDINGS, AFTER DECEMBER 31, 2011

All applications for building permit for Part 9 residential buildings submitted after December 31, 2011 are required to demonstrate that the building has the performance level that would be achieved by a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses".

After December 31, 2011 the options of complying with the provisions of Division B, Subsection 12.3.2. or 12.3.3. will no longer be available. The application of the requirements for Subsection 12.3.2. and 12.3.3. are covered in Modules 2 and Module 3, respectively.



PART 9, NON-RESIDENTIAL BUILDINGS, UP TO DECEMBER 31, 2011

Part 9 non-residential buildings (that do not have electric space heating) can follow any one of the **three possible options** for energy efficient design.

Sentence 12.2.1.1.(2) sets out the minimum requirements relative to energy efficiency for Part 9 non-residential buildings intended for occupancy on a continuing basis during winter months. Any one of the following provisions can be applied:

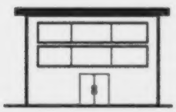
Division B, Sentence 12.2.1.1.(2)

(a) ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings" and Supplementary Standard SB-10,

(b) the Model National Energy Code for Buildings and Supplementary Standard SB-10.

Division B, Sentence 12.2.1.1.(4) provides a third alternative to meet the energy efficiency of a Part 9 non-residential occupancy:

(c) *...the design requirements of Subsection 12.3.4*



PART 9, NON-RESIDENTIAL BUILDINGS, AFTER DECEMBER 31, 2011

All applications for building permit for Part 9 non-residential buildings submitted <u>after December 31, 2011</u> are required to exceed the energy efficiency levels attained by applying the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) by 25%.

The application of the requirements for Subsection 12.3.4. are covered in Modules 5 – 11.

<u>EXAMPLE</u>

A designer wants to design a Part 9 residential building applying the provisions of Subsection 12.3.2. What is the last day that the designer has to submit the application for permit?

<u>Solution:</u>

→ Sentence 12.2.1.1.(1) sets out the limitations of applying Subsection 12.3.2. and 12.3.3. as design compliance options for Part 9 residential buildings

→ The last day the designer can apply for building permit is December 31, 2011 if he wants to apply the Thermal Insulation Compliance Option (Subsection 12.3.2.)

EXAMPLE

A designer wants to design a Part 9 non-residential building that will have a forced air gas heating system. It is anticipated that the building permit application will be submitted in 2008. Is the designer permitted to use the provisions of Subsection 12.3.4. to meet the minimum energy efficiency requirements?

Solution:

→ Sentence 12.2.1.1.(1) sets out the limitations of applying Subsection 12.3.4. as a design compliance option for Part 9 non-residential buildings that does not have electric space heating

→ The last day the designer can apply for building permit is December 31, 2011 if the designer wants to apply the provisions of 12.3.4.

→ Therefore, the designer may use the provisions of Subsection 12.3.4. to meet the minimum energy efficiency requirements

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 1-3

Can the provisions for Subsection 12.3.3. be used as a design compliance option for a Part 9 townhouse if the designer submits his application for building permit prior to January 1, 2012?

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Code Ref.:________________________________

EXERCISE 1-4

A designer wants to design a Part 9 office building without electric space heating. What are the different compliance options the designer may use to meet the minimum energy efficiency requirements if the building permit application is submitted in 2008?

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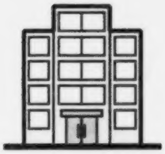
Code Ref.:________________________________

STOP



ALL OTHER BUILDINGS, UP TO DECEMBER 31, 2011

All other buildings (including Part 3 buildings and Part 9 non-residential buildings with electric space heating) are required to comply with good engineering design. Two examples of good engineering design include ASHRAE/IESNA 90.1 "Energy *Standard for Buildings Except Low-Rise Residential Buildings*" in conjunction with Supplementary Standard, SB-10, or the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) in conjunction with Supplementary Standard, SB-10.

Other design approaches can also be applied if they meet the performance level of good engineering design.

ALL OTHER BUILDINGS, AFTER DECEMBER 31, 2011

After December 31, 2011, all other buildings (including Part 3 buildings and Part 9 non-residential buildings with electric space heating) are required to be designed to exceed the energy efficiency levels attained by conforming to the 1997 edition of the "Model National Energy Code for Buildings" (MNECB). The design must exceed the energy efficiency levels of the MNECB by at least 25%.

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 1-5

A designer wants to design a Part 9 office building with electric space heating. What are the different compliance options the designer may use to meet the minimum energy efficiency requirements if the building permit application is submitted in 2008?

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Code Ref.:________________________________

EXERCISE 1-6

What are the energy efficiency requirements for a 700 m^2 home if the building permit application is submitted after December 31, 2011?

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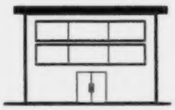
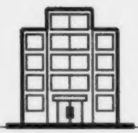
Code Ref.:________________________________

STOP

SUMMARY OF ENERGY EFFICIENCY DESIGN COMPLIANCE OPTIONS

The table below outlines all applicable energy efficiency design compliance options for all buildings.

	Energy Efficiency Design Compliance Option	Applicable up to Dec. 31, 2011	Applicable after Dec. 31, 2011	Code Reference
	Thermal Insulation (Under Subsection 12.3.2.)	✓	--	12.2.1.1.(3)(a)
	Thermal Design (Under Subsection 12.3.3.)	✓	--	12.2.1.1.(3)(b)
	NRCan "EnerGuide for New Houses"	✓	✓	12.2.1.1.(3)(c) and 12.2.1.2.(3)
	ANSI/ASHRAE/IESNA 90.1 and SB-10	✓	--	12.2.1.1.(2)(a)
	MNECB and SB-10	✓	--	12.2.1.1.(2)(b)
	Subsection 12.3.4.	✓	--	12.2.1.1.(4)(a)
	MNECB + 25%	--	✓	12.2.1.2.(2)
	ANSI/ASHRAE/IESNA 90.1 and SB-10	✓	--	12.2.1.1.(2)(a)
	MNECB and SB-10	✓	--	12.2.1.1.(2)(b)
	MNECB + 25%	--	✓	12.2.1.2.(2)

✓ Applicable -- Not Applicable

STOP

SUPPLEMENTARY STANDARD SB-10 "ENERGY EFFICIENCY STANDARD"

Throughout Part 12, extensive reference is made to SB-10. These references are made only for provisions applying to both Part 3 and Part 9 non-residential buildings.

SB-10 is organized into 3 chapters with the following general content:

Chapter 1: identifies the application and exemptions common to both ASHRAE 90.1 and the MNECB.

Chapter 2: contains modifications to the ASHRAE 90.1 Standard.

Chapter 3: contains modification to the MNECB.

When applying either the ASHRAE 90.1 or MNECB, SB-10 should be consulted and applied. The modifications, including additions or substitutions found in the provisions of SB-10 supercede the corresponding provisions in the ASHRAE 90.1 or MNECB.

Some of the Part 12 provisions which reference SB-10 include:

- Thermal bridging concepts for thermal resistance of the building envelope for Part 9 buildings of non-residential occupancy. (Module 5)
- HVAC systems for Part 9 buildings of non-residential occupancy. (Module 8)
- Electric motors for Part 9 buildings of non-residential occupancy. (Module 10)
- Fluorescent lighting ballasts for Part 9 buildings of non-residential occupancy. (Module 11)

The technical content and the ways that SB-10 applies are discussed in applicable modules for each of the above provisions.

SB-10 does not apply to the following buildings:

- Part 9 residential occupancy
- Heritage buildings
- Buildings that uses less than $12 W/m^2$ under peak conditions
- Temporary structures
- Warehouse or storage areas where the indoor temperature is less than 10°C
- Unheated storage garages, except where conditioned spaces are exposed to unheated storage areas.

EXAMPLE

Identify the type of building to which the provisions of Article 12.3.4.6. apply.

Solution:

→ Article 12.3.4.6. forms part of Subsection 12.3.4. Referring back to Sentence 12.3.4.1.(1):

...This subsection applies to the energy efficiency of buildings or part of buildings described in Sentence 12.2.1.1.(4).

→ Sentence 12.2.1.1.(4) sets out the application of Subsection 12.3.4

→ Therefore, Article 12.3.4.6. applies to Part 9 non-residential buildings that do not use electric space heating.

STOP

COMPLETE THE NEXT THREE EXERCISES

EXERCISE 1-7

A Part 3 residential building is being designed, and the building permit application will be submitted in 2009. Which of the following provisions does the designer have to satisfy to meet the minimum energy efficiency requirements?

(a) Provisions of Subsection 12.3.3. or 12.3.4.

(b) ANSI/ASHRAE/IESNA 90.1 and SB-10

(c) MNECB and SB-10

(d) Any one of (b) or (c)

____

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Code Ref.:________________________________

EXERCISE 1-8:

For the following design requirements, identify: **(a)** all building types to which the provisions apply if the building permit application is submitted prior to January 1, 2012 and **(b)** Code references that identifies the application of the provision.

Design Requirements	(a)				(b)
	Part 9-Residential	Part 9 Non-Residential[1]	All other Buildings	N/A	Code Ref.
Example: Thermal Insulation Compliance Option (Under Subsection 12.3.2.)	✓				Clause 12.2.1.1.(3)(a)
Energy efficiency levels of MNECB + 25% (Under Sentence 12.2.1.2.(2))					
Thermal Resistance of Building Envelope (Under Article 12.3.4.2.)					
Performance level of an 80 rating if evaluated using NRCan EnerGuide					
ANSI/ASHRAE/IESNA 90.1 and SB-10					

[1] Part 9 non-residential buildings that do not have electric space heating

EXERCISE 1-9

For the following design requirements, identify: **(a)** all building types to which the provisions apply if the building permit application is submitted after December 31, 2011and **(b)** Code references that include the application of the provision.

Design Requirements	(a)				(b)
	Part 9-Residential	Part 9 Non-Residential[2]	All other Buildings	N/A	Code Ref.
Thermal Insulation Compliance Option (Under Subsection 12.3.2.)					
Energy efficiency levels of MNECB + 25% (Under Sentence 12.2.1.2.(2))					
Thermal Resistance of Building Envelope (Under Article 12.3.4.2.)					
NRCan EnerGuide rating of 80					
ANSI/ASHRAE/IESNA 90.1 and SB-10 (Under Sentence 12.2.1.1.(2))					

END

[2] Part 9 non-residential buildings that do not have electric space heating.

MODULE 2

PART 9 RESIDENTIAL
THERMAL INSULATION COMPLIANCE OPTION

TABLE OF CONTENT

INTRODUCTION

This module describes how the provisions for thermal insulation (under Subsection 12.3.2.) can be used as a compliance option to meet the energy efficiency performance requirements for Part 9 residential buildings.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the application of thermal insulation compliance option (Subsection 12.3.2.)
- Identify the minimum requirements for thermal resistance of insulation
- Classify locations to specific degree-day zones
- Identify the impacts of thermal bridging in various types of construction
- Recognize the exceptions to thermal resistance values at roof and ceiling assemblies
- Identify the thermal conductance requirements for windows and sliding doors
- Identify the thermal conductance requirements for doors
- Identify the impact of electric space heating on doors and glazing in dwelling units
- Identify the thermal resistance requirements for log walls construction and post, beam and plank construction
- Identify the insulation requirements for slab-on-ground

- Apply different provisions for insulation of foundations before and after December 31, 2008
- Identify the requirements for control of convection currents in masonry construction
- Identify minimum efficiency requirements for furnaces

READ TO THE NEXT STOP.

APPLICATION OF TE THERMAL INSULATION COMPLIANCE OPTION

Sentence 12.2.1.1.(3) sets out the minimum requirements for Part 9 residential buildings relative to energy efficiency. **Three different compliance options** are offered so that a designer can choose any option to meet the minimum energy efficiency requirements. As per Division B, Sentence 12.2.1.1.(3), any <u>one</u> of clauses (a), (b) or (c) can be applied.

Division B, Sentence 12.2.1.1.(3)

The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,

(a) Conform to the thermal insulation requirements of Subsection 12.3.2.

(b) Conform to the thermal design requirements of Subsection 12.3.3.

OR

(c) Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures'

A designer can comply with the prescriptive requirements for thermal resistance of insulation set out in Subsection 12.3.2. as one way of providing an energy efficient design if application for a building permit has been made up to December 31, 2011.

All applications for building permits for Part 9 residential buildings submitted after December 31, 2011 will be required to demonstrate that they have the performance level of a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses" as required by Division B, Sentence 12.2.1.2.(3).

MEASURE OF THERMAL PERFORMANCE OF BUILDING ELEMENTS

Thermal performance of a building element is evaluated in terms of its resistance to heat flow. The thermal resistance of a building element may be expressed in terms of:

- RSI value,
- R-value, or
- U-value

RSI (Resistance System International) is a metric measure ($m^2 {}^\circ C/W$) of the thermal resistance, or resistance to heat flow. The higher the RSI value, the higher the insulating capability of the material or system.

The imperial measure of thermal resistance is **R-Value** (hr $ft^2 {}^\circ F/BTU$), which is a common measure of insulating capability in the United States, and is still widely understood in Canada. RSI and R-value are related as follows:

$$RSI = R\text{-value} \div 5.678$$

RSI and R-Value are measurements of thermal resistance. Another measure of thermal performance of a building element is in terms of its thermal conductivity. Thermal conductance, often defined as a **U-value** (W/m^2°C), is a measurement of the ability of a material to conduct heat.

Thermal conductance is inversely related to thermal resistance. As R-Value or RSI increases, the U-value decreases.

The following figure displays the relationship between the popular measures of insulating capability of building elements:

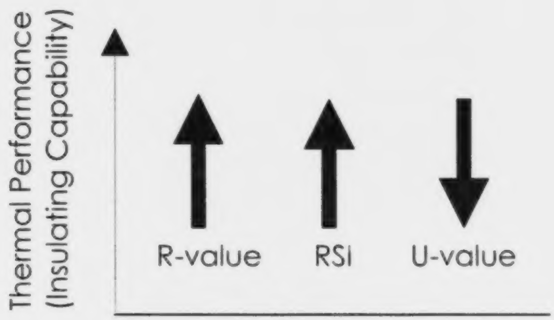

Figure 2-1 Relationship Between Measures of Thermal Performance (Building Elements)

MINIMUM REQUIREMENTS FOR THERMAL RESISTANCE OF INSULATION

Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" sets out the minimum thermal resistance values (RSI) for **insulation** that forms part of a building assembly that separates a heated space from the exterior or to an unheated space for Part 9 residential buildings. In addition to the Part 12 requirements, the insulation must conform to the requirements of Division B, Subsection 9.25.

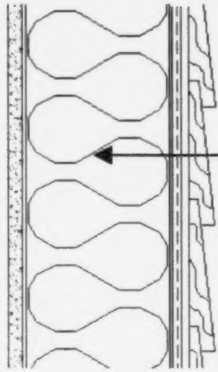

Figure 2- 2 Minimum RSI Values of Insulation

As presented earlier, the thermal resistance value (RSI) is a measurement of resistance to heat flow. The higher the resistance value, the slower the rate of heat transfer through the insulating material.

When applying Table 12.3.2.1., the minimum required RSI values for insulation in specific building assemblies are dependant on where the building is located (i.e. town or city) or whether electric space heating is used in the building.

As defined in Division A, Article 1.4.1.2., electric space heating means:

> *... an electric energy source that provides more than 10 per cent of the heating capacity provided for a building and includes,*
>
> *(a) electric resistance unitary baseboard heating,*
>
> *(b) electric resistance unitary cabinet heating,*
>
> *(c) electric resistance ceiling cable or floor cable heating,*
>
> *(d) electric resistance central furnace heating,*
>
> *(e) electric hot water space heating, and*
>
> *(f) air source heat pumps in combination with electric resistance backup heating.*

If **electric heating is used**, the minimum overall RSI values in Column 4 of Table 12.3.2.1. are used, regardless of the geographical location of the building in Ontario.

Otherwise, if **electric space heating is not used**, the minimum RSI values in Table 12.3.2.1. (Column 2 and 3) are dependant on the location of the building and are classified into two zones.

The thermal resistance values (RSI) are determined based on the energy required to **heat** a building. The amount of energy to heat a house is dependant on the number of heating degree-days. This information can be found for Ontario towns and cities in SB-1, Table 1.2 "Design Data for Selected Locations in Ontario".

For the purposes of determining the minimum thermal resistance value for a building element, a town or city is classified in one of the following two degree-day zones:

Zone 1: Heating Degree-days < 5000/year

Zone 2: Heating Degree-days ≥ 5000/year

STOP

HEATING DEGREE-DAYS

The minimum thermal resistance values (RSI) set out in Table 12.3.2.1. "Minimum thermal Resistance of Insulation to be installed Based on Degree-Day Zones" are dependant on the heating degree-days for the location of the building.

As described in SB-1, when the average outside temperature is 18°C or more, it is assumed that no energy is required for the purposes of these calculations. As such, only the daily temperatures below 18°C contribute to heating degree-days.

The number of annual heating degree-days (HDD) is calculated using the following approach:

$$HDD = \sum_{n=1}^{365} 18 - T_{avg.day\_n}$$

or

$$HDD = (18 - T_{avg.day1}) + (18 - T_{avg.day2}) + \ldots + (18 - T_{avg.day365})$$

→ $T_{avg,\ day\ n}$ is the average temperature on that day.

This calculation has been completed for you and can be found in SB-1, Table 1.2. "Design Data for Selected Locations in Ontario" for specific locations in Ontario.

EXAMPLE

What is the number of heating degree-days for three successive winter days having a mean temperature of 2°C on Day 1, −4°C on Day 2 and −1°C on Day 3?

Solution:

$$HDD = \sum_{n=1}^{3} 18 - T_{avg.day\_3}$$

$$HDD = (18 - T_{avg.day1}) + (18 - T_{avg.day2}) + (18 - T_{avg.day3})$$

$$HDD = (18 - 2) + (18 - (-4)) + (18 - (-1))$$
$$HDD = 16 + 22 + 19$$
$$HDD = 57$$

COMPLETE THE NEXT EXERCISE

EXERCISE 2-1

Using SB-1, determine the annual number of heating degree-days below 18°C for Peterborough.

(a) 5150

(b) 4400

(c) 710

(d) 840

Code Ref.:____________________________________

STOP

EXAMPLE

Identify the degree-day zone for each of the following locations:

- Sault Ste. Marie
- Pembroke

Solution:

→ Referring to Table 1.2 "Design Data for Selected Locations in Ontario" in SB-1, locate the number of heating degree-days (Column 6):

- Sault Ste. Marie: 5100
- Pembroke: 5000

→ Based on the definition of Zone 1 and Zone 2 from Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" of the Code

Zone 1: Heating Degree-days < 5000/year

Zone 2: Heating Degree-days ≥ 5000/year

- Sault Ste. Marie: Zone 2
- Pembroke: Zone 2

COMPLETE THE NEXT THREE EXERCISES

EXERCISE 2-2

Identify the heating degree-days (HDD) and the HDD zone for each of the following cities and towns:

City or Town	Heating Degree-Days	HDD Zone
Example: Belleville	**4100**	**1**
Ajax		
Timmins		
Dryden		
Thunder Bay		
Aurora		

Code Ref.:______________________________

EXERCISE 2-3

A new 2 storey motel having a footprint area of 550 m^2 will be constructed in Sault Ste. Marie and will have electric space heating. The designer chose the thermal insulation compliance option to meet the minimum energy efficiency requirements. What is the minimum required RSI for insulation for each of the following building elements if building permit application is submitted in 2010?

Exterior walls: ________________

Foundation walls: ________________

Interior walls: ________________

Ceiling below attic: ________________

Code Ref.: ______________________________

EXERCISE 2-4

A new Part 9 residential building is being designed in Ajax with natural gas heating. What are the minimum RSI values that apply to the insulation in the following building assemblies if the building is being designed using the thermal insulation compliance option?

Building Assembly	Minimum RSI value ($m^2 \cdot °C/W$)
Basement floor located at 500 mm below grade that does not contain heating piping, tubes, ducts, or cables:	
Ceiling below attic space:	
Exterior Wall:	
Ground floor:	

Code Ref.:__________________________________

STOP

IMPACT OF THERMAL BRIDGING AND METAL THERMAL BRIDGES

The minimum thermal resistance values identified in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" apply through the insulation only and does not apply at framing or furring elements.

The calculation of thermal resistance, when measured at a stud or furring channel, can be significantly less than the thermal resistance across the insulated portion of the assembly. The effect of thermal resistance at studs and furring channels is known as thermal bridging. A thermal bridge is a material that connects the warm side of the building assembly to the cold side and that has a greater thermally conductivity compared to other adjacent materials.

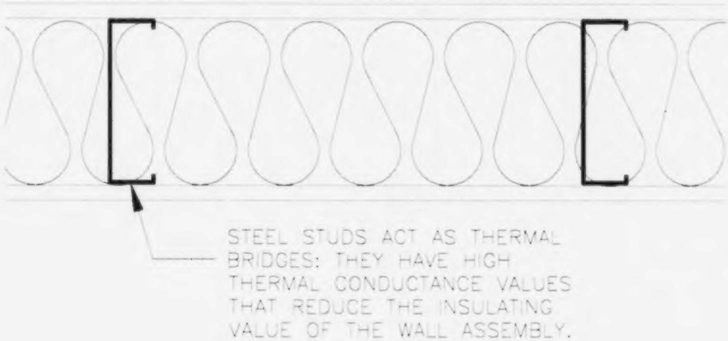

Figure 2- 3 Steel Studs that Act as Thermal Bridges

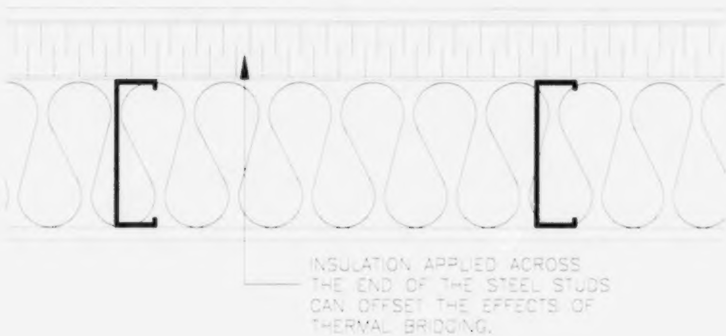

Figure 2- 4 Example of no Thermal Bridging with Steel Studs

The thermal resistance values set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" do not need to be adjusted to consider the localized thermal bridging effect of **wood** studs.

However, **steel** studs are more thermally conductive than wood studs and reduce the thermal resistance of the building assembly when compared to a similar wood stud framed assembly. The thermal resistance values of Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" do not consider metal framing elements that act as thermal bridges.

To compensate for the negative impact of metal framing, the minimum RSI values set out in Table 12.3.2.1. must be increased.

Article 12.3.2.2. sets out provisions to reduce the effects of thermal bridging for insulated portions of a wall. These provisions include increasing the RSI values otherwise required by Sentence 12.3.2.1.(4).

Division B, Article 12.3.2.2.

1. *Except for a foundation wall, the insulated portion of a wall that incorporates wood stud framing elements that have a thermal resistance of less than RSI 0.90 shall be insulated to restrict heat flow through the studs by a material providing a thermal resistance at least equal to 25 per cent of the thermal resistance required for the insulated portion of the assembly in Sentence 12.3.2.1.(4).*

(2) Except as provided in Sentence (3), the thermal resistance of the insulated portion of a building assembly in Sentence 12.3.2.1.(4) that incorporates metal framing elements, such as steel studs and steel joists, that act as thermal bridges to facilitate heat flow through the assembly, shall be 20 per cent greater than the values shown in Table 12.3.2.1, unless..."

The 20% increase of the RSI values is **not** required if:

- *"...it can be shown that the heat flow is not greater than the heat flow through a wood frame assembly of the same thickness."* [Division B, Sentence 12.3.2.2.(2)]

OR

- Metal thermal bridges are insulated by a material having an RSI of 25% of the values set out in Table 12.3.2.1. [Division B, Sentence 12.3.2.2.(3)]

COMPLETE THE NEXT EXERCISE

EXERCISE 2-5

A new 500 m^2 motel will be built in Guelph. If steel stud framing elements are proposed in lieu of wood stud framing elements (in accordance with Sentence 12.3.2.2.(2)), what is the minimum RSI value of the following building elements:

Building Element	Minimum RSI Value ($m^2°C/W$)
Basement floor located at 500 mm below grade that does not contain heating piping, tubes, ducts, or cables:	
Ceiling below attic space:	
Exterior wall:	
Ground floor:	

Code Ref.:________________________________

STOP

EXCEPTIONS TO THERMAL RESISTANCE VALUES REQUIREMENTS

The minimum thermal resistance (RSI) values set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" apply to most building elements. However, there are some exceptions in determining the RSI value for the following building elements:

- Roof and ceiling assemblies at edges
- Windows
- Doors
- Log wall and post, beam and plank construction.
- Foundation walls

These exceptions are discussed below.

Also, under Sentence 12.3.2.1.(3) **reflective surfaces do not** contribute to the RSI value of the insulation. For example foil back insulation will not have an increased RSI because of the reflective surface. Only the insulation material will contribute to the thermal resistance value.

THERMAL RESISTANCE REQUIREMENTS FOR ROOF AND CEILING ASSEMBLIES

The minimum thermal resistance values set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" for roofs and ceilings exposed to the exterior or to unheated spaces may be reduced near eaves.

Division B, Sentence 12.3.2.3.(1)

> *...to the extent made necessary by the roof slope and required ventilation clearances...*

However, a minimum RSI value of **not less than 2.1 m²°C/W** is required for insulation installed directly above the inner surface of the exterior wall.

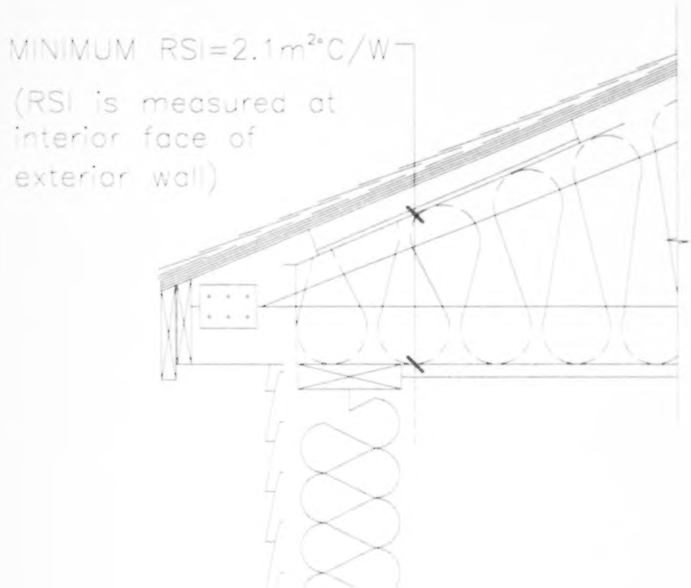

Figure 2- 5 Reduction in Thermal Insulation due to Roof Slope and Required Ventilation

STOP

MEASURE OF THERMAL PERFORMANCE OF GLAZING AND DOORS

Whereas the thermal performance of walls, roofs and foundations are measured in terms of **thermal resistance**, the thermal performance of windows and doors are measured in terms of **thermal conductance**.

Thermal conductance is a measure of heat transfer of a material or an assembly.

Thermal performance of glazing and doors may be expressed in terms of:

- RSI value,
- R-value,
- Overall U-value/Coefficient of heat transfer, or
- Energy rating

As described earlier in this module, RSI, R-value and U-value are a measure of thermal resistance or conductance for building elements. This same principal applies to glazing. When applying the U-value to windows, overall U-value applies and all elements of the window assembly are considered, including the window frame and glazing, air space or argon-fill, etc.

In addition to thermal resistance, glazing can also be represented in terms of overall U-value or **coefficient of heat transfer** ($W/m^2 \cdot C$), which is a measure of thermal conductance and is the inverse of the RSI value. Whereas an increase in RSI represents an increase in the thermal performance of a material, an increase in thermal conductance represents a decrease in thermal performance of the material.

Materials with a higher relative thermal conductance have a lower insulation capability.

$$\text{Coefficient of heat transfer} = \frac{1}{RSI}$$

The **energy rating** (W/m^2) is a rating system adopted by CSA A440.2., where the energy rating represents the following:

Energy rating = Positive solar gains
- transmission losses
- infiltration losses

The coefficient of heat transfer and the energy rating for windows and sliding doors are determined using the methods described in CAN/CSA-A440.2, "Energy Performance Evaluation of Windows and Sliding Glass Doors".

Window manufacturers usually undertake the determination of these factors.

It is important to verify that the information is provided with the same units as shown in the Code. Manufacturers typically provide thermal performance properties of windows systems, but they are often provided in measures different from the coefficient of heat transfer.

RSI, R-value, and U-value have previously been discussed in this Module. Often, manufacturers identify a U-value as an indicator of thermal performance. The U-value (inverse of R-value) is also a measure of thermal conductance of a building element.

The following figure displays the relationships between the popular measures and the relative thermal performance and insulating capability of building elements:

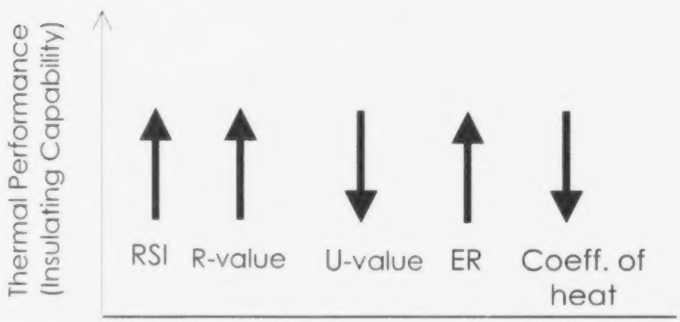

Figure 2- 6 Relationship Between Measures of Thermal Performance (Building Elements)

STOP

THERMAL CONDUCTANCE REQUIREMENTS FOR WINDOWS AND SLIDING DOORS

Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" does not include the minimum thermal properties for windows or sliding doors.

The minimum thermal performance requirements for glazing are set out in Division B, Articles 12.3.2.6. "Thermal Resistance of Windows" and 12.3.2.7. "Minimum Thermal Resistance of Doors."

Article 12.3.2.8. sets out the maximum thermal conductance for doors and glazing that separates heated spaces from unheated spaces in dwelling units that use electric space heating.

The Code prescribes conductance limits in terms of coefficient of heat transfer and energy rating.

If applying the thermal insulation compliance option for **windows or sliding glass doors**, generally, glazing must meet one of the following:

Excerpts from Division B, Sentence 12.3.2.6.(1) and 12.3.2.7.(2)

(a) An overall coefficient of heat transfer of not more than 2.0 W/m²°C

OR

(b) An energy rating of not less than,

- *(i) 17 for operable windows and sliding glass doors*
- *(ii) 27 for fixed windows*

Glazing in windows and sliding glass doors that separate **electrically heated spaces** from unheated spaces have more stringent performance requirements in dwelling units:

Division B, Article 12.3.2.8.

(a) An overall coefficient of heat transfer of not more than 1.6 W/ m²°C

OR

(b) An energy rating of not less than
- *(i) 25 for operable windows and sliding glass doors*
- *(ii) 35 for fixed windows.*

In addition, basement windows that incorporate a load-bearing structural frame are required to be double glazed with low-E coating.

EXAMPLE

A new house with electric space heating is being designed in a Zone 1 (less than 5000 heating degree-days). What is the minimum energy rating of an operable window if the building permit application is submitted in 2009?

Solution:

→ Determine applicable Article for thermal performance of windows

- Article 12.3.2.6. applies to all windows
- However, Article 12.3.2.8. applies to doors and glazing with electric heating
- Since the provisions in Article 12.3.2.8. are more specific than the general provisions of Article 12.3.2.6. the provisions of Article 12.3.2.8. apply

→ Determine minimum energy rating.

- Subclause 12.3.2.8.(2)(b)(i) requires all operable windows in an electrically heated house to have an energy rating of 25.

→ Therefore the minimum energy rating of an operable window is 25.

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 2-6

A new 550 m^2 2 storey motel with natural gas heating is being designed in Mississauga using the thermal insulation option. Determine the **minimum thermal performance** requirements (i.e. over all coefficient of heat transfer and energy rating) for the following glazing if the building permit application is submitted prior to 2010:

(a) Glazed sliding doors provided for ground floor rooms

____

____

Code Ref.: ______________________________

(b) Fixed windows provided for rooms on the second floor

____

____

Code Ref.: ______________________________

(c) Operable windows provided in common areas on the ground floor.

____

____

Code Ref.: ______________________________

STOP

DOORS THERMAL CONDUCTANCE REQUIREMENTS

Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" does not include the minimum thermal resistance values for doors.

The minimum thermal resistance requirements for doors are set out in Sentence 12.3.2.7.(1) and 12.3.2.8.(1) specifically for sliding doors in dwelling units where the sliding doors separate heated spaces from unheated spaces.

Sentence 12.3.2.7.(1) is applicable to all doors that separate heated space from the outside, except doors on enclosed unheated vestibules and cold cellars or where storm doors are provided.

As per Sentence 12.3.2.7.(1), the non-glazed (opaque) portions of doors are required to have a minimum thermal resistance of not less than RSI 0.7. The glazed portions of doors do not have any thermal conductance requirements.

STOP

THERMAL RESISTANCE REQUIREMENTS FOR LOG WALL CONSTRUCTION AND POST, BEAM AND PLANK CONSTRUCTION

Article 12.3.2.9. sets out the **minimum** thermal resistance requirements for log wall, and post, beam and plank construction.

Division B, Sentence 12.3.2.9.(1)

> *...log wall construction and post, beam and plank construction shall have a minimum thermal resistance of RSI 2.1 for the total assembly.*

However, the minimum thermal resistance value of 2.1 $m^{2}°C/W$ is permitted to be reduced to an RSI of 1.61 $m^{2}°C/W$ as per Division B, 12.3.2.9.(2) as follows:

Division B, Sentence 12.3.2.9.(2)

The thermal resistance value in Sentence (1) for the total wall assembly may be reduced to not more than RSI 1.61 if,

(a) the thermal resistance of insulation for the exposed roof or ceiling required in Table 12.3.2.1. is increased by an amount equivalent to the reduction permitted in this Sentence

AND

(b) for log walls, the logs have tongue-and-groove or splined joints.

Also, the minimum thermal resistance value of 2.1 m^2°C/W is **not required** for **milled** log walls by Division B, 12.3.2.9.(3):

Division B, Sentence 12.3.2.9.(3)

*Where milled log walls are installed, the thermal resistance value in Sentence (1) for the total wall assembly does **not** apply if,*

(a) the mean thickness of each log is not less than 150 mm,

(b) the thermal resistance of insulation for the exposed roof or ceiling required in Table 12.3.2.1. is increased by 0.53, and

(c) the logs have tongue-and-groove or splined joints.

Figure 2-7 Splined Joint

EXAMPLE

A new 550 m^2 log hotel with natural gas heating will be constructed in Orillia. Using the provisions of 12.3.2., what is the minimum required RSI value of the total wall assembly if the each milled log will have an average thickness of at least 200 mm and have splined joints, and the exposed roof will be insulated with insulation having an RSI of 5.0 m^2°C/W?

Solution:

→ Sentence 12.3.2.9.(1) requires an RSI of 2.1 m^2°C/W for total wall assemblies.

→ However, an RSI 2.1 m^2°C/W can be reduced to as low as 1.6 m^2°C/W if the 3 conditions of Sentence 12.3.2.9.(3) are met.

- 2 conditions are met: (a) Each milled log has a mean thickness of at least 150 mm, and (b) the logs have splined joints.
- 1 condition is not met: (c) Insulation values in Table 12.3.2.1. for exposed roof or ceilings must be increased by 0.53 m^2°C/W. Therefore, insulation must have an RSI of 5.46 m^2°C/W.

(Required: 5.46 m^2°C/W > Proposed: 5.0 m^2°C/W)

→ Therefore, the minimum RSI value of the total wall assembly is 2.1 m^2°C/W

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 2-7

A new log house heated with natural gas will be constructed in 2010 in Kenora. The designer wants to apply the provisions of Subsection 12.3.2. as a compliance option to meet the energy efficiency requirements. What is the minimum RSI value for an exposed roof in order to have an RSI value of 1.8 $m^2 °C/W$ for the total wall assembly?

(a) 7.00 $m^2 °C/W$

(b) 5.23 $m^2 °C/W$

(c) 4.93 $m^2 °C/W$

(d) 4.63 $m^2 °C/W$

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STOP

INSULATION OF SLAB-ON-GROUND

Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" contains minimum RSI values for slab-on-ground. These values are applicable as further described by Division B, Article 12.3.2.4.

The RSI values from Table 12.3.2.1. are permitted to be reduced in accordance with Division B, Sentence12.3.2.4.(7) by 50% as follows:

Division B, Sentence 12.3.2.4.(7)

> *...if the underside of the entire slab-on-ground is insulated.*

However, as per Division B, 12.3.2.4.(6), the insulation installed around concrete slab-on-ground is required to extend at least 600 mm below the ground level.

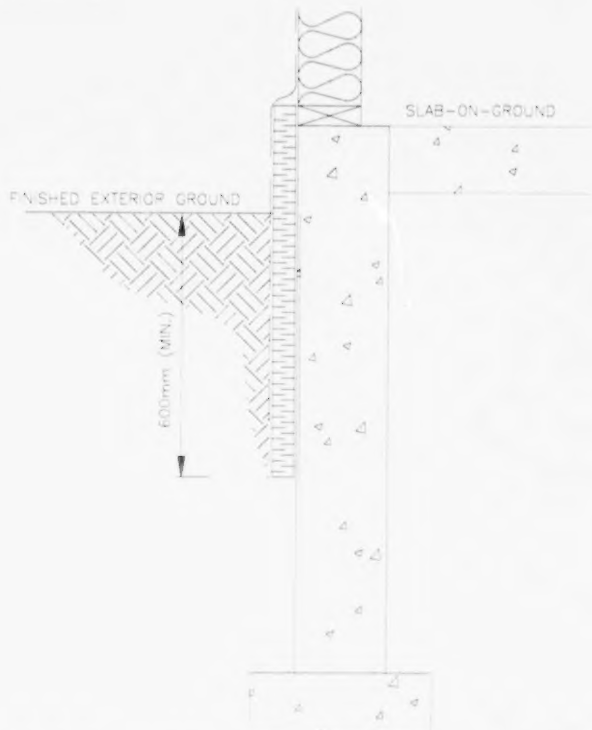

Figure 2- 8 Thermal Insulation Installed Vertically for Slab-on-Ground

EXAMPLE

A new house is being designed in Halton Hills, Ontario. What is the minimum thermal resistance value for a basement concrete floor slab that will be installed at 1200 mm below grade when applying the thermal insulation compliance option?

Solution:

→ The RSI requirements are set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones"

- Basement floor slabs located more than 600 mm below grade do not have minimum RSI values.

→ The basement floor slab does not have any minimum requirements for RSI values.

COMPLETE THE NEXT EXERCISE

EXERCISE 2-8

A new house is being designed in Halton Hills, Ontario with a gas-fired forced air heating system. What is the minimum thermal resistance of the insulation installed around the perimeter of the slab-on-ground when applying the thermal insulation compliance option? The slab-on-ground contains heating pipes, and the slab will be located 300 mm below grade.

(a) 1.76 m^2°C/W

(b) 1.41 m^2°C/W

(c) 0.88 m^2°C/W

(d) 0.71 m^2°C/W

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STOP

INSULATION OF FOUNDATION WALLS

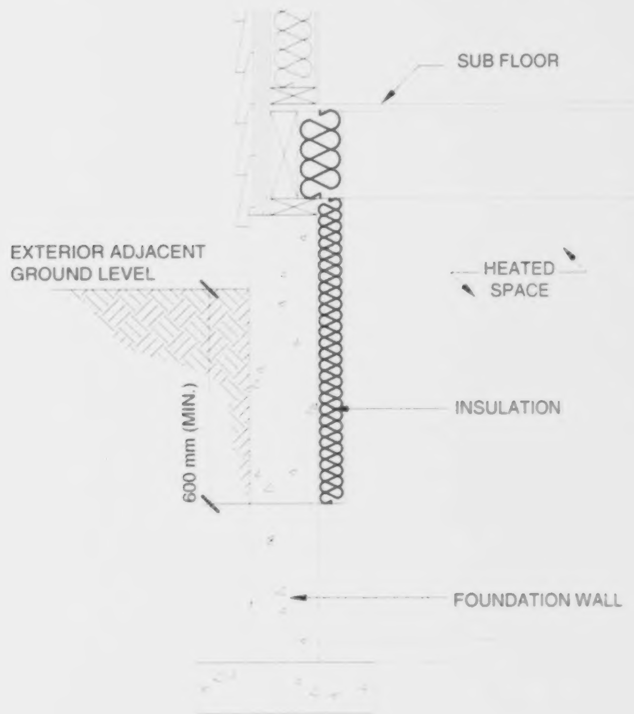
Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" contains a minimum required RSI value for foundation walls. These values are applicable as further described by Division B, Article 12.3.2.4.

Building permits submitted up to December 31, 2008 are required to meet the following.

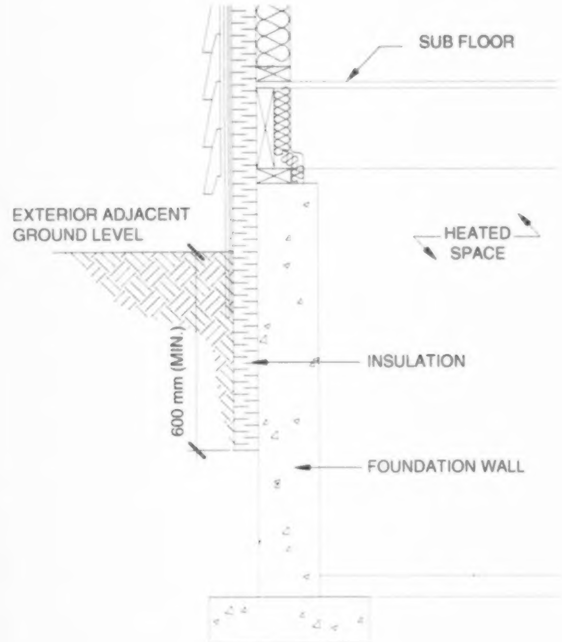
Division B, Sentence 12.3.2.4.(2)

> *Foundation walls enclosing heated space shall be insulated from the underside of the subfloor to not less than 600 mm below the adjacent exterior ground level.*

Insulation installed along the foundation wall is required to be installed to a minimum depth of 600 mm below the adjacent exterior ground level.



(a)



(b)

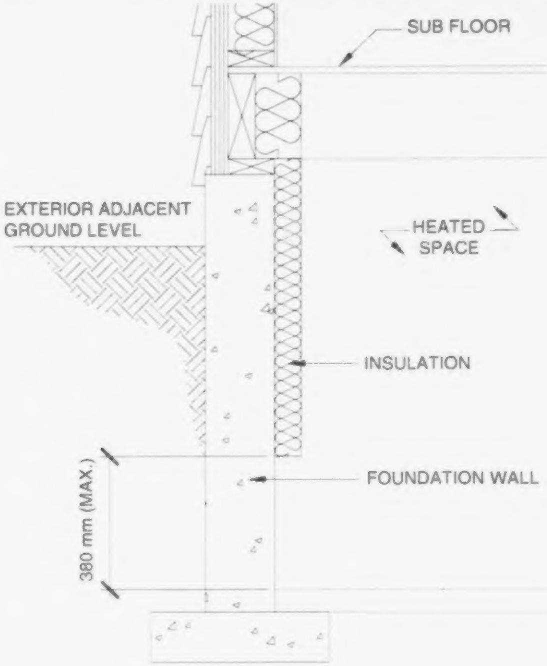
Figure 2- 9 Insulation Requirements for Foundation Walls Designed up to December 31, 2008 (a) Insulation Installed on the Interior (b) Insulation Installed on the Exterior

Building permits submitted <u>after December 31, 2008</u> are required to meet the following.

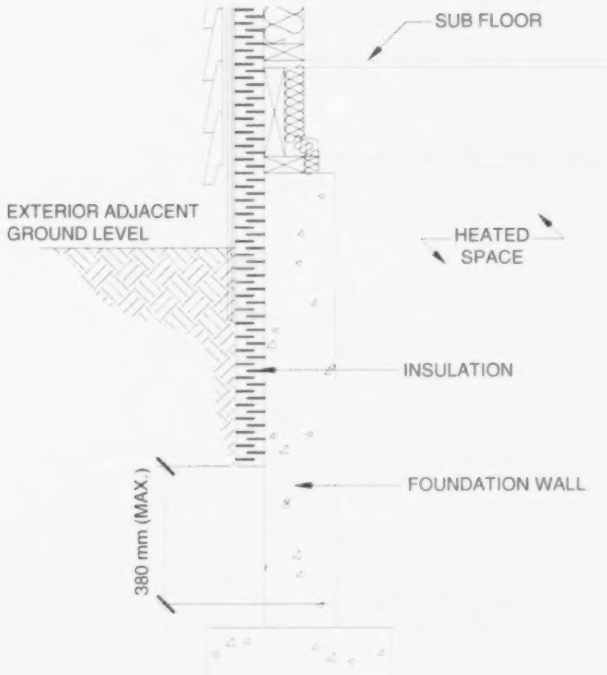
Division B, Sentence 12.3.2.4.(4)

> *Foundation walls enclosing heated space shall be insulated from the underside of the subfloor to not more than 380 mm above the finished floor level of the basement.*

Insulation installed on exterior walls is required to be installed to within 380 mm above the finished floor to limit excessive energy consumption.



(a)



(b)

Figure 2- 10 Insulation Requirements for Foundation Walls Designed After December 31, 2008 (a) Interior insulation (b) Exterior Insulation

The installation of the insulation around the foundation wall can be installed on the interior, exterior, or a combination of interior and exterior to provide the minimum performance described in Figure 2-10 is achieved.

CONTROLLING CONVECTION CURRENTS IN MASONRY WALLS

Convective movement of air can result when the surface of a material is at a different temperature than the adjacent air. Convective airflow can reduce the thermal performance of a building and can carry moisture to problematic locations.
To limit convection currents in the core spaces of masonry units, appropriate air and surface temperatures must be maintained and moisture condensation must be limited. To do so, **foundation walls** constructed of hollow masonry units are required to conform to Sentence 12.3.2.4.(8).

Division B, Sentence 12.3.2.4.(8)

> *If a foundation wall is constructed of hollow masonry units, one or more of the following shall be used to control convective air currents in the core spaces,*
>
> *(a) Filling the core spaces*
>
> *(b) at least one row of semi-solid blocks at or below grade*
>
> *OR*
>
> *(c) other similar methods.*

These requirements are in addition to the minimum requirements for the insulation of foundation walls.

Masonry walls constructed of hollow units that penetrate the ceiling must be sealed at or near the adjacent roof space to prevent convection currents from entering the attic or roof space in accordance with one of the provisions of Sentence 12.3.2.4.(9).

Division B, Sentence 12.3.2.4.(9)

Masonry walls of hollow units that penetrate the ceiling shall be sealed at or near the ceiling adjacent to the roof space to prevent air within the voids from entering the attic or roof space by,

(a) capping with masonry units without voids, or

(b) installation of flashing material extending across the full width of the masonry.

Also note that Sentence 9.20.8.1.(1) requires a similar feature at the top of hollow masonry walls.

STOP

EQUIPMENT EFFICIENCY FOR PART 9 RESIDENTIAL BUILDINGS

In addition to conforming to the thermal insulation compliance option for energy efficiency, all Part 9 residential buildings are required to meet minimum furnace efficiencies.

The minimum furnace fuel utilization efficiency requirements are set out in Article 12.3.1.2. The efficiency requirements are based on the fuel source of the furnace.

Table 12.3.1.2 "Furnace Minimum Annual Fuel Utilization Efficiency" prescribes minimum annual fuel utilization efficiency ratings for natural gas, propane and oil furnaces.

COMPLETE THE NEXT EXERCISE

EXERCISE 2-9

Using Table 12.3.1.2., what is the minimum annual fuel utilization efficiency of a propane furnace that will be installed in a 185 m^2 house?

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END

MODULE 3

PART 9 RESIDENTIAL THERMAL DESIGN COMPLIANCE OPTION

RESOURCE CONSERVATION ALL BUILDINGS – 2006

TABLE OF CONTENT

INTRODUCTION

This module describes how the provisions for thermal design (under Subsection 12.3.3.) can be used as a compliance option to meet the energy efficiency performance requirements for Part 9 residential buildings.

The thermal design compliance option recognizes the contribution of all elements in the building assembly. This design option differs from the thermal insulation design option described in Module 2 since the thermal insulation compliance option only addresses the thermal resistance value of the insulation.

The thermal design compliance option described in this Module and set out in Subsection 12.3.3. is required to be designed by an architect and/or by a professional engineer, as described in Division C, Sentence 1.2.1.1.(6).

OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify applicable Part 9 requirements for materials, crawl spaces, roof spaces, ventilation and HVAC
- Apply Table 12.3.3.3. for determining minimum thermal resistance of building assemblies
- Recognize the exceptions when determining the minimum thermal resistance of building assemblies
- Calculate and apply factors to adjust thermal insulation requirements for thermal bridging of steel stud wall assemblies
- Identify the option to reduce thermal resistance of roof and ceiling assemblies by consideration of total calculated heat loss

- Recognize the differences for required insulation of foundations before and after January 1, 2009
- Identify the thermal insulation requirements for slab-on-ground
- Identify and understand the concept of thermal inertia
- Calculate the total area of glazing and apply glazing area limits
- Identify conditions for performance of windows and doors
- Calculate the maximum air infiltration at various points of air entry
- Identify minimum efficiency requirements for furnaces.

READ TO THE NEXT STOP.

APPLICATION OF THE THERMAL DESIGN COMPLIANCE OPTION

Sentence 12.2.1.1.(3) sets out the minimum requirements for Part 9 residential buildings relative to energy efficiency. **Three different compliance options** are offered so that a designer can choose any option to meet the minimum energy efficiency requirements. As per Division B, Sentence 12.2.1.1.(3), any <u>one</u> of clauses (a), (b) or (c) can be applied.

Division B, Sentence 12.2.1.1.(3)

> *The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,*
>
> *(a) Conform to the thermal insulation requirements of Subsection 12.3.2.*

(b) Conform to the thermal design requirements of Subsection 12.3.3.

OR

(c) Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures'

A designer can apply the prescriptive thermal design requirements set out in Subsection 12.3.3. as one way of providing an energy efficient design if application for a building permit has been made up to December 31, 2011.

All permit applications for Part 9 residential buildings submitted after December 31, 2011 will be required to meet the performance level that is greater or equal to a rating of 80 when evaluated in accordance to NRCan "EnerGuide for New Houses".

PART 9 REQUIREMENTS ARE STILL APPLICABLE!

Generally, building assemblies are required to meet the following minimum Part 9 requirements.

Division B, Article 12.3.3.2.

(1) ... thermal insulation and vapour barrier protection shall conform to Section 9.25.

(2) Foamed plastic thermal insulation shall be protected as described in Article 9.10.17.10.

(3) Crawl spaces shall conform to Section 9.18.

(4) Roof spaces shall conform to Section 9.19.

(5) Ventilation requirements shall conform to Section 9.32.

(6) Heating and air-conditioning requirements shall conform to Section 9.33.

The above noted Part 9 provisions apply in addition to the energy efficiency provisions of Part 12.

The thermal design compliance option, discussed in this Module, takes into consideration the thermal effects of different elements of the building assembly, such as sheathing or gypsum board.

STOP

MINIMUM THERMAL RESISTANCE FOR BUILDING ASSEMBLIES

The thermal design compliance option under Subsection 12.3.3. takes into consideration the insulating contribution from all elements of the building assembly. This approach differs from the thermal insulation compliance option described in Module 2, which only considers the thermal properties of the insulation that is part of an assembly.

Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" sets out the minimum thermal resistance values (RSI) for building **assemblies** separating a heated space from an unheated space or the exterior.

RSI is the acronym for "Resistance Système International", which is the metric equivalent of R-value and is expressed in terms of $m^2{}^\circ C/W$.

The ***minimum RSI values for building assemblies set out in Table 12.3.3.3.*** "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" apply through the portions of the building assembly at locations other than where there is:

- Framing

Or

- Furring

The effect of framing and furring channels is addressed separately by considering their contribution as thermal bridges. This effect will be considered later in this Module.

Each building element (such as insulation or interior gypsum board or exterior sheathing) contributes to the overall RSI value of the assembly and has its own RSI value. The overall RSI value of the building assembly is the sum of the RSI values of each building element in the building assembly.

The overall RSI value of the building assembly does not consider furring or spacers, therefore the RSI value is calculated at a location where furring or spacers are not provided.

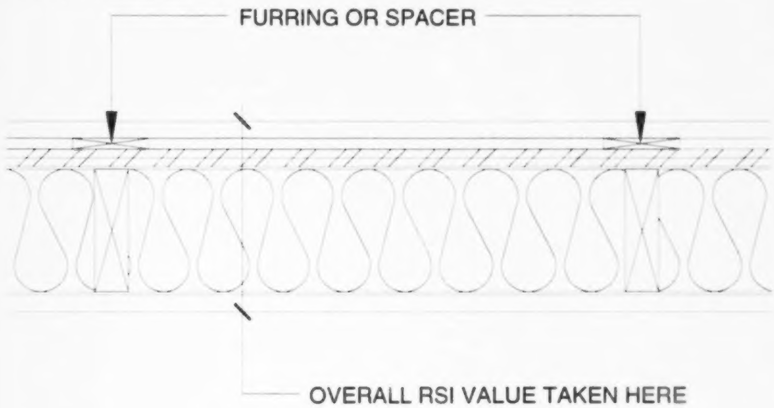


Figure 3- 1 Furring or Spacers not Considered for RSI of Assembly

When applying Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones", the minimum required RSI values for specific building assemblies are dependant on where the building is geographically located (i.e. town or city) or whether electric space heating is used in the building.

If **electric space heating is used**, the minimum overall RSI values in Column 4 of Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" are used. These requirements are generally more stringent.

Otherwise, if **electric space heating is not used**, the minimum RSI values in Table 12.3.2.1. (Column 2 and 3) are dependant on the location of the building and are classified into two zones.

The thermal resistance values (RSI) are determined based on the energy required to **heat** a building. The amount of energy to heat a building is dependant on the number of heating degree-days. This information can be found for Ontario towns and cities in SB-1, Table 1.2 "Design Data for Selected Locations in Ontario".

For the purposes of determining the minimum thermal resistance value for a building element, a town or city is classified in one of the following two degree-day zones:

Zone 1: Heating degree-days < 5000/year

Zone 2: Heating degree-days ≥ 5000/year

However, the minimum RSI values for the **assemblies** described in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" are different from the minimum RSI values for **insulation** in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" which applies when the thermal insulation compliance option is used (Module 2).

HEATING DEGREE-DAYS

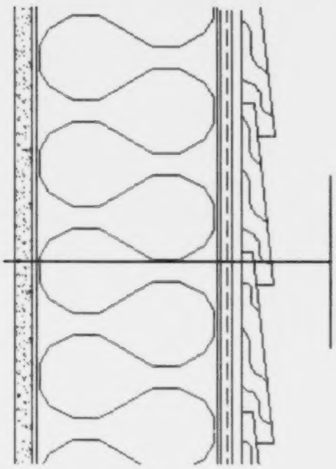
The minimum RSI values found in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" considers the energy required to heat a building.

Except for buildings with electric space heating, the minimum required RSI values for the assembly is dependant on the number of heating degree-days found in SB-1, Table 1.2. "Design Data for Selected Locations in Ontario"

Note: Refer to Module 2 to review the determination of heating degree-days

EXAMPLE

An Architect is proposing the following exterior wall section for a new house built in Cornwall, Ontario. Does this wall meet the minimum design requirements for thermal resistance based on the application of the thermal design compliance option and Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones"?



Solution:

→ From SB-1, Table 1.2, Cornwall has 4350 annual heating degree-days. This number corresponds to Zone 1.

→ Referring to Table 12.3.3.3. an exterior wall assembly for a Part 9 residential building must have an RSI of at least 3.8

→ The thermal resistance value of the assembly is the sum of all the individual elements.

- $RSI_{Total} = 0.2 + 0.1 + 3.5 + 0.1$
- $RSI_{Total} = 3.9\ m^2{}^\circ C/W$

→ Therefore the proposed wall ($3.9\ m^2\ ^\circ C/W$) meets the minimum thermal resistance requirements ($3.8\ m^2\ ^\circ C/W$).

COMPLETE THE NEXT EXERCISE

EXERCISE 3-1

A new 2 storey motel having a foot print area of 500 m^2 will be constructed in Stratford, Ontario. The building permit application will be submitted in 2009. The heating system will be natural gas. What is the minimum RSI for the exterior wall assembly and the interior floor assembly of the second floor?

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STOP

EXCEPTIONS TO THERMAL RESISTANCE VALUES FOR BUILDING ASSEMBLIES

The minimum thermal resistance (RSI) values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" apply to most building assemblies. However, there are some exceptions and other considerations in determining the minimum RSI value.

Exceptions apply for:

- Metal thermal bridges
- Roof and ceiling assemblies only at edges
- Foundation walls
- Slab-on-ground
- Windows and glazing

- Doors
- Air Infiltration
- Reduction of thermal resistance

These exceptions are discussed below.

METAL THERMAL BRIDGES

As previously noted, the minimum thermal resistance values that are identified in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" apply through the portion of the assembly that does not include framing and furring. The calculation of thermal resistance, when measured at a stud or furring channel can be significantly less than the thermal resistance across the insulation portion of the assembly. The effect on thermal resistance of studs and furring channels is known as thermal bridging. A thermal bridge is a material that connects the warm side of the building assembly to the cold side and that has a greater thermal conductivity compared to other materials.

The thermal resistance values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" do not need to be adjusted to consider the localized thermal bridging effect of **wood** studs.

However, **steel** studs are more thermally conductive than wood studs and reduce the thermal resistance of the building assembly when compared to a similar wood stud framed assembly. The thermal resistance values of Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" do not consider metal framing elements that act as thermal bridges.

To compensate for the negative impact of metal framing, the minimum RSI values set out in Table 12.3.3.3. must be increased.

Division B, Sentence 12.3.3.4.(1)

> *… the thermal resistance of the insulated portion of a building assembly that incorporates metal framing elements, such as steel studs and steel joists, that act as thermal bridges … shall be 20 per cent greater than the values shown in Table 12.3.3.3.…*

The 20% increase of the RSI values is not required if:

- The heat flow through the portion with the metal thermal bridge **is not greater** than the heat flow through a wood thermal bridge of a building assembly of the same thickness. (Division B, Sentence 12.3.3.4.(1))

OR

- metal thermal bridges are insulated by a material having an RSI of 25% of the values set out in Table 12.3.3.3. (Division B, Sentence 12.3.3.6.(1))

ROOF AND CEILING ASSEMBLIES THERMAL RESISTANCE REQUIREMENTS

The minimum thermal resistance values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" and in Article 12.3.3.4. for roofs and ceilings exposed to the exterior or to unheated spaces may be reduced near eaves "*…to the extent made necessary by the roof slope and required ventilation clearances…*" as per Division B, Sentence 12.3.3.7.(1)

However, a minimum RSI of **at least 2.1 m^2°C/W** is required for assemblies installed directly above the inner surface of the exterior wall.

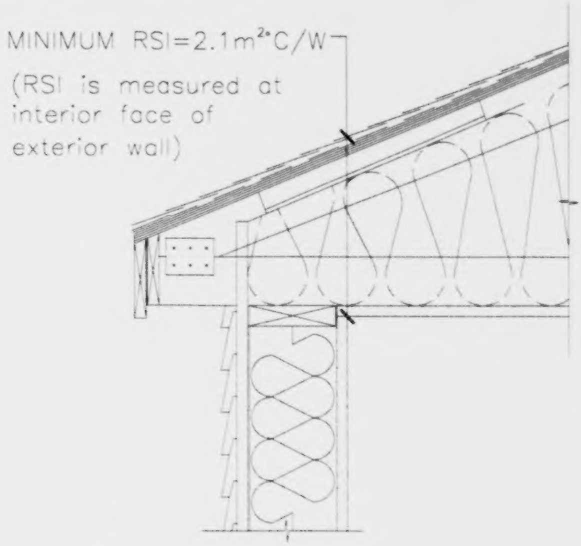

Figure 3- 2 Reduction in Thermal Insulation due to Roof Slope and Required Ventilation

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 3-2

A new Part 9 residential building will be designed in conformance with the thermal design compliance option. The new building will be constructed in Cobourg, what is the minimum RSI value for an exposed roof assembly at the following locations:

(a) Near eaves, measured at the inner surface of the exterior wall

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(b) All other locations of the roof assembly

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STOP

INSULATION OF FOUNDATION WALLS

Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" contains a minimum required RSI value for foundation walls enclosing heated space. These values are applicable as further described by Division B, Article 12.3.3.9.

The requirements for insulation of foundation walls for the thermal design compliance option are the same requirements set out in the thermal insulation compliance option described in Module 2.

Refer to Module 2 for the minimum requirements of Insulation of Foundation Walls

EXAMPLE

A new 2-storey 500 m^2 college residence is being designed for a college in Kingston. The designer will use the thermal design compliance option to meet energy efficiency requirements. The building will be heated with a forced air gas system. What is the minimum required thermal resistance value (RSI) of the foundation wall if the building permit application is submitted in 2008?

Solution:

→ Minimum thermal resistance values are set out in Table 12.3.3.3. when using the thermal design compliance option.

→ Since the building is heated with a forced air gas system, column 4 in Table 12.3.3.3. is not applicable.

→ The RSI values for foundation wall associated to Zone 1 and Zone 2 are identical. Therefore, there is no need to determine the heating degree-day zone for Kingston.

→ Therefore, the minimum RSI value for the foundation wall is 2.40 $m^2 \cdot {}^\circ C/W$.

COMPLETE THE NEXT EXERCISE

EXERCISE 3-3

The foundation wall for the building described in the example above is required to be insulated. To what depth must the insulation extend along the inside or outside surface of the foundation wall?

(a) At least 600 mm below the adjacent ground level

(b) To not more than 600 mm below the adjacent ground level

(c) To within 380 mm above the finished basement floor

(d) To more than 380 mm above the finished basement floor

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STOP

SLAB ON GROUND INSULATION

The minimum thermal resistance values set out in Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" are applicable to the insulation installed beneath the slab-on-ground.

The insulation applied to the exterior edge of the slab-on-ground is required to be at least 600 mm in length.

Division B, Sentence 12.3.3.9.(5) provides two options for the installation of insulation along the exterior edge of the slab-on-ground:

- Extend down vertically at least 600 mm below the adjacent ground level (Figure 3-3)

OR

- Extend down and outward from the floor or wall for a total distance of at least 600 mm measured from the adjacent ground level. (Figure 3-4)

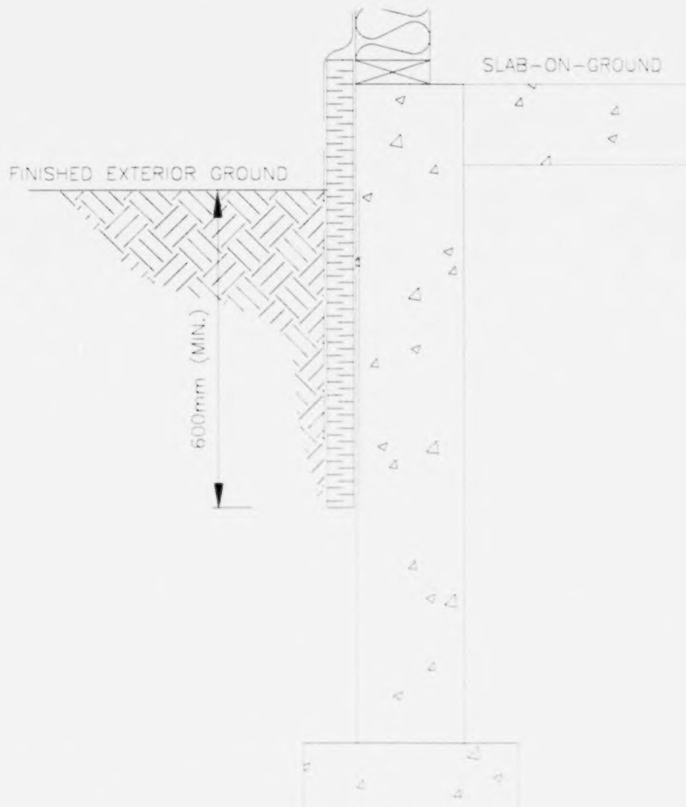
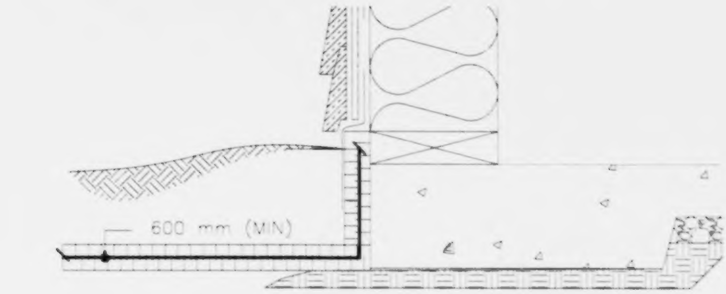
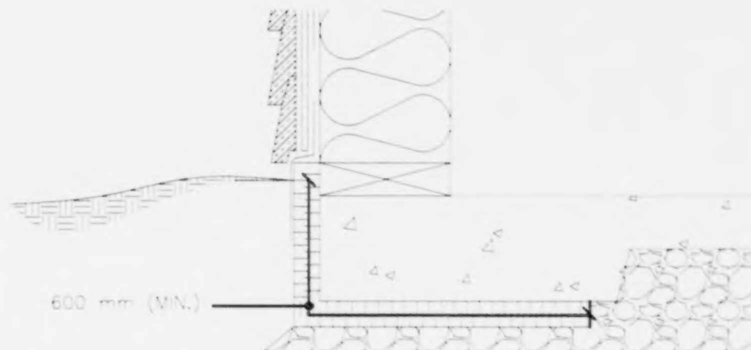


Figure 3- 3 Thermal Insulation Installed Vertically for Slab-on-Ground



(a)



(b)

Figure 3- 4 Two Configurations for Thermal Insulation Installed Down and Outward from the Floor or Wall

Note that the structural properties for the insulation should be considered.

REDUCTION IN THERMAL RESISTANCE

The minimum thermal resistance values set out in Articles 12.3.3.3. and 12.3.3.4. for building assemblies are permitted to be reduced up to 20% under the following conditions:

As per Division B, Sentence 12.3.3.6.(1)

> *...where it can be shown that the total calculated **heat loss** from the building enclosure does not exceed the heat loss that would result **if** the enclosure were constructed in conformance with ...Articles 12.3.3.3. and 12.3.3.4.*

This Sentence allows engineered designs to be applied if the total calculated heat loss does not exceed the heat loss that would result if the enclosure were constructed by applying the referenced provisions. However, to apply this approach, the window area limits set out in Sentence 12.3.3.6.(1) must be met without any consideration for solar heat gain or orientation of the glazing.

Sentence 12.3.3.8.(1) also permits a reduction in the thermal resistance values set out in Table 12.3.3.3. to take into account the **thermal mass** of the building.

Thermal mass is a measure of the capability to store heat. Buildings with relatively high thermal mass will reduce and slow down the effects of sudden change in exterior temperature on the building's interior air temperature.

STOP

WINDOWS AND SLIDING DOORS THERMAL RESISTANCE REQUIREMENTS

Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" does not include minimum thermal resistance values for windows and sliding doors. However, Article 12.3.3.11. sets out the minimum energy performance of windows and other glazing for the thermal design option. Two options for window performance are provided, including:

- Application of Articles 12.3.2.6. and 12.3.2.8. (Part of the thermal insulation compliance option – Module 2)

OR

- Application of Sentences 12.3.3.11.(2) and (3) (Part of the thermal design compliance option – Module 3)

For the second option, Sentences 12.3.3.11.(2) does not consider the performance of the windows and glazing, but prescribe a maximum area of glazing to separate heated space from an unheated space or the exterior.

TOTAL GLAZING AREA CALCULATION

The maximum area of glazing can be determined by applying the limitations set out in Sentence 12.3.3.11.(2).

The maximum area of glazing on a storey is required to satisfy both of the following criteria:

- Maximum 20% of the floor area of the storey,

  AND

- Maximum 40% of the area of the walls on the storey

When applying this calculation, remember:

- Include all glazing in windows, doors and skylights,

and

- For sloped walls, use the entire wall area projected onto a vertical plane (include opaque and non-opaque portions of sloped wall).

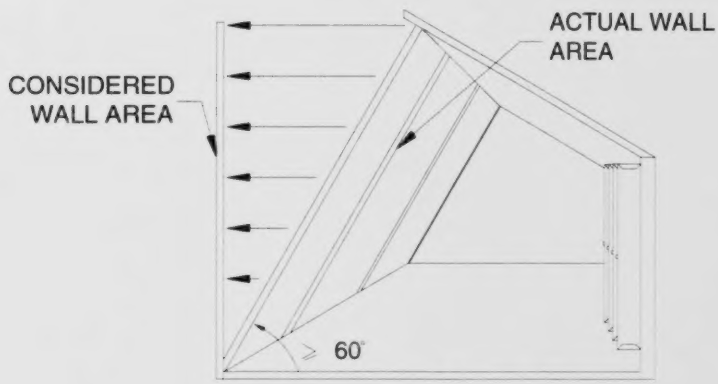


Figure 3- 5 Projection of Sloped Wall with Glazing

A sloped wall is described in Sentence 9.10.1.2.(1) as having a slope of 60˚or more to the horizontal. Where the slope of the assembly is at an angle less than 60˚, the assembly is considered to be a roof.

As permitted by Sentences 12.3.3.11.(3) and (4), the actual glazing area may differ from the calculated maximum glazing area if:

- The thermal resistance of the actual glazing is different than that referenced by Articles 12.3.2.6.,12.3.2.8., and 12.3.3.10.

OR

- There are positive effects of winter solar gain and summer shading.

The determination of winter solar gain and summer shading is explored later in this module.

By applying either of the above factors, the actual glazing may have a different performance than that which was used to establish the area limits in Sentence 12.3.3.11.(2). When glazing area is permitted since it has performance characteristics that exceed that prescribed by Articles 12.3.2.6. and 12.3.2.8., the effect is that larger glazing area has the same performance as a smaller glazed area that just meets the criteria.

As was seen in Module 2B, thermal resistance of glazing is measured in terms of thermal conductance by assessing the performance of glazing in terms of coefficient of heat transfer and energy rating.

> Note: Refer to Module 2 to review thermal resistance, heat transfer coefficient and energy rating.

In addition to the area and performance requirements, basement windows that incorporate a loadbearing structural frame are required to be double glazed with low-E coating.

Different requirements apply where electric space heating is used. These are discussed later in the module.

Before proceeding to examine ways that the window area can be increased, the following example and exercises are provided to become familiar with the basic calculation procedures.

EXAMPLE

Take a few minutes to read Sentence 12.3.3.11.(2)

A new motel is being designed having the following dimensions: 35 m wide, 15 metres deep, and a storey height of 2.5 metres. Assume the glazing just meets thermal resistance requirements of 12.3.2.6, and ignore the effects of winter solar gain. Calculate the maximum glazing area permitted per storey when applying the thermal design compliance option.

Solution:

→ The floor area of a storey is
35 m x 15 m = 525 m^2

- 20% of 525 m^2 is 105 m^2 of glazing

→ The total wall area of the storey is
(35 m + 35m +15 m + 15 m) x 2.5 m = 250 m^2

- 40% of 275 m^2 is 100 m^2 of glazing.

→ Since both criteria apply, the lower of the two glazing area calculations is the maximum glazing area that is permitted.

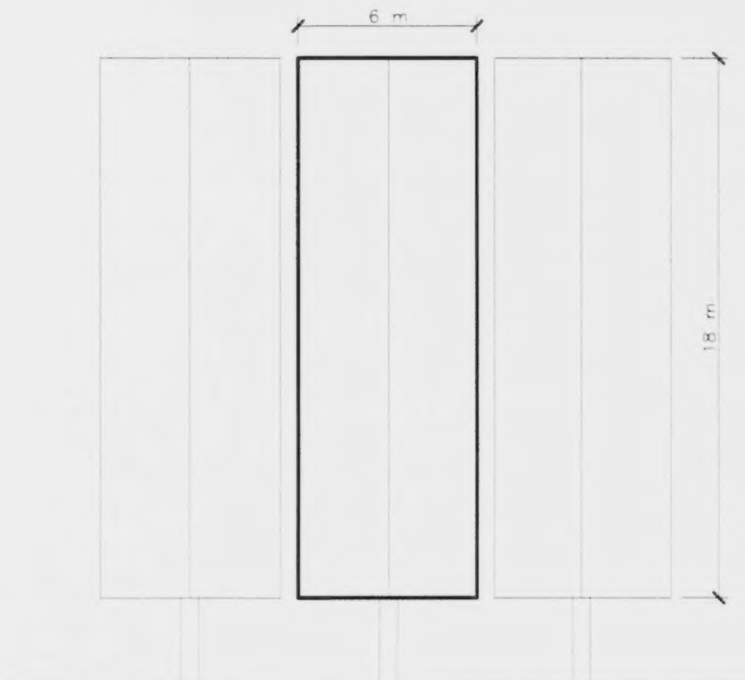
→ Therefore, the maximum glazing area permitted is 100 m^2.

STOP

COMPLETE THE FOLLOWING TWO EXERCISES

EXERCISE 3-4

A developer is planning to build a 2 storey townhouse on an infill lot. Due to site constraints, glazing is not permitted in the side walls, so the developer wants to maximize the glazing on the front and rear walls of the first storey. The house will be 6 metres wide, 18 metres deep, and each storey is 3 metres high.



PLAN VIEW

ELEVATION PLAN

What is the total permitted area of glazing for each storey?

(a) 50.4 m^2

(b) 21.6 m^2

(c) 57.6 m^2

(d) 21.6 m^2

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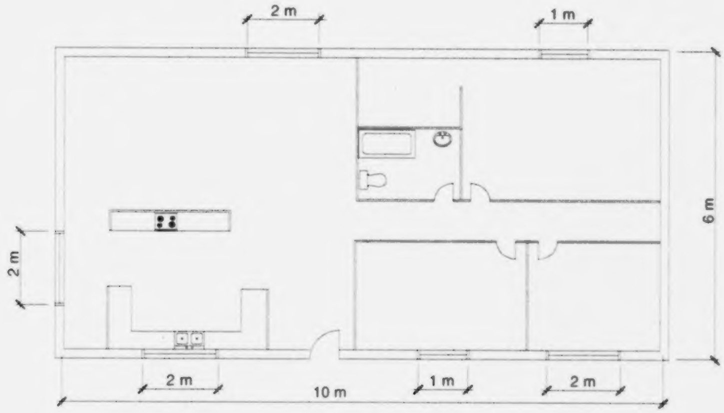
EXERCISE 3-5

The plans for the first storey of a house (6 m by 10 m) are showing glazing as described in the figure below. All windows are 1 m high and the door does not have any glazing.



Calculate the maximum permitted glazing area and assess whether the proposed glazing meets the conditions of Sentence 12.3.3.11.(2).

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STOP

RATIO OF ACTUAL VERSUS REQUIRED THERMAL RESISTANCE OF WINDOWS AND DOORS

As noted earlier, Sentence 12.3.3.11.(3) allows glazing with different performance characteristics (other than those prescribed by Article 12.3.2.6 and 12.3.2.8) to be compared to the performance that would be achieved if compliant with the prescribed characteristics, and the area of the proposed glazing is permitted to be adjusted to account for those differences.

Before assessing the ratio of the difference between actual and minimum performance requirements, the performance characteristics from Articles 12.3.2.6. and 12.3.3.8. are revisited. These are the same criteria that were reviewed in Module 2.

The two criteria are coefficient of heat transfer and energy rating.

The coefficient of heat transfer ($W/m^2 {}^\circ C$) is a measure of the thermal properties of the material. The coefficient of heat transfer is the inverse of the thermal resistance value (RSI).

$$\text{Coefficient of Heat Transfer} = \frac{1}{RSI}$$

The energy rating (W/m^2) is a separate measure of energy performance of a window that accounts for other factors, such as solar gains and thermal losses. Both the coefficient of heat transfer and the energy rating can be obtained from the window manufacturer.

The ratio that is applied to the proposed glazing area in order to compare to the maximum permitted area from Sentence 12.3.3.11.(2) is called the **glazing factor**. The glazing factor is the ratio of the required versus the actual thermal resistance of the glazing. The actual proposed glazing area can be adjusted by the glazing factor to determine the effective area, as follows:

Effective Area = Glazing Factor X Actual Area

Where:

- Effective area: Area to be compared to maximum permitted area
- Actual area: Area of proposed glazing

$$\text{Glazing factor} = \frac{\text{RSI value (required)}}{\text{RSI value (actual)}} \qquad \text{(Eqn. 1)}$$

However, glazing properties are usually provided as **coefficient of heat transfer** ($m^2{}^\circ C/W$), which is the inverse of thermal resistance (RSI value). As such, the glazing factor should be applied as follows:

Glazing factor =

$$\frac{\dfrac{1}{\text{coefficient of heat transfer (required)}}}{\dfrac{1}{\text{coefficient of heat transfer (actual)}}} \qquad \text{(Eqn. 2.1)}$$

OR

Glazing factor =

$$\frac{\text{coefficient of heat transfer (actual)}}{\text{coefficient of heat transfer (required)}} \qquad \text{(Eqn. 2.2)}$$

As an alternative solution, using the Objective-Based Code when glazing properties are provided in terms of **energy rating**, the glazing factor may also be calculated as follows:

$$\text{Glazing factor} = \frac{\text{energy rating (required)}}{\text{energy rating (actual)}} \qquad \text{(Eqn. 3)}$$

As seen before, glazing can meet one of two conditions from Article 12.3.2.6.:

- Maximum overall coefficient of heat transfer of 2.0 W/m²C,

  OR

- Minimum energy rating of 17 (operable windows or sliding glass doors) and 27 (fixed windows).

Different criteria apply to sliding doors or windows where electric space heating is used in a dwelling unit as per Article 12.3.2.8.

EXAMPLE

A window has a coefficient of heat transfer of 1.0 W/m²C.

(a) What is the ratio that can be applied to the actual glazing area to determine the effective glazing area?

(b) Will a coefficient of heat transfer of 1.0 W/m²C permit more, or less glazing than that calculated from Sentence 12.3.3.11.(2)?

Solution:

(a) To calculate the ratio, the actual coefficient of heat transfer is divided by the required coefficient of heat transfer (Eqn 2.2), as provided in Sentence 12.3.3.11.(3)

→ Glazing factor = $\dfrac{\text{coefficient of heat transfer (actual)}}{\text{coefficient of heat transfer (required)}}$

→ Glazing factor = 1.0 ÷ 2.0 = 0.5

(b) A window with a lower coefficient of heat transfer will perform better than one with a higher coefficient of heat transfer. The glazing factor of 0.5 has the effect of reducing the negative impacts and the effective area of a window that will be compared to the maximum permitted window area.

→ Therefore, a larger glazing area is permitted than that calculated from Sentence 12.3.3.11.(2).

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 3-6

It was determined that the total permitted fixed glazing area for a 1 storey building was 90 m^2. The designer would like to have a total glazing area of 120 m^2. What minimum energy rating must be specified such that the performance level of the glazing will be equivalent to a total fixed glazing area of 90 m^2.

(a) Energy rating of 27

(b) Energy rating of 36

(c) Energy rating of 17

(d) Energy rating of 20.25

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STOP

IMPLICATIONS OF SHADING

As seen previously, Sentence 12.3.3.11.(3) allows for an increase in glazing area if the actual thermal resistance of the proposed glazing is greater than that referenced by Articles 12.3.2.6 and 12.3.2.8.

In addition to Sentence 12.3.3.11.(3), the glazing area calculation can also be modified to consider the positive effects of winter solar heat gain.

This calculation is set out in Sentence 12.3.3.11.(4). The following conditions must be met in order to apply the positive effects of winter solar heat gain:

- Glazing must be clear glass, or have a shading coefficient of more than 0.70.
- Glazing must be unshaded in winter (shading calculated using the noon sun angles of December 21).
- Glazing must face within 45 degrees of due south.
- The house must have a system that is capable of distributing the solar heat gain throughout the building, such as a forced air heating system.
- If the building has a cooling system, the glazing must be shaded in the summer with exterior devices (shading calculated using the noon sun angles of June 21).

The area of glazing that meets the above criteria is permitted to be considered as 50% of the unshaded area. In other words, this glazing would count as only half of its actual area when calculating the overall glazing on the storey to confirm that the overall glazing area meets the limits of Article 12.3.3.11.

Factors contributing to noon sun angles include latitude and tilt of the earth, which is fixed on December 21st and June 21st for all locations.

NOON SUN ANGLES

On June 21, the northern hemisphere of the earth is tilted 23.5° towards the sun. Whereas on December 21, the northern hemisphere of the earth is tilted 23.5° away from the sun.

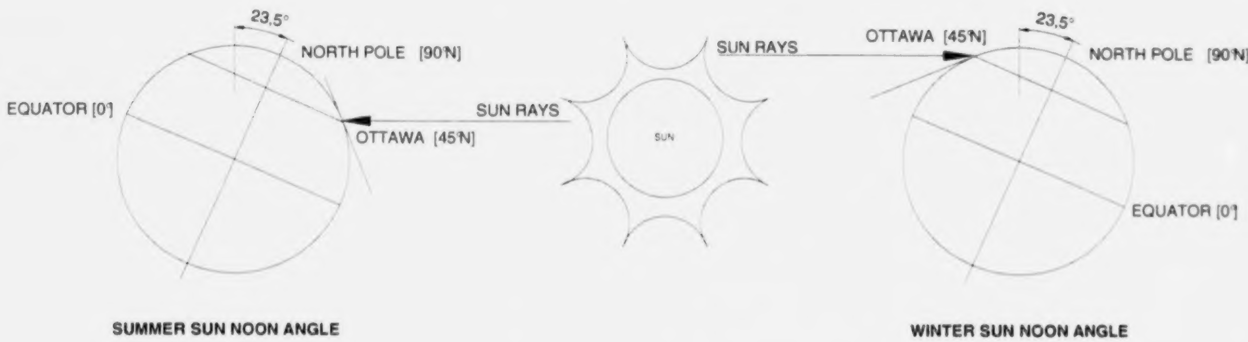


Figure 3- 6 Schematic of Noon Sun Angles (Example provided for Ottawa)

To calculate the noon sun angle in Ontario, the following formula can be applied:

Noon sun angle = 90° – (Latitude of Location - D)

Where:

D= - 23.5° on December 21st (Winter)

D = + 23.5° on June 21st (Summer)

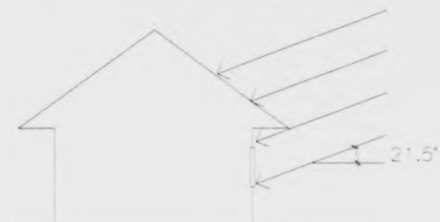
EXAMPLE

A new 1 storey house will be constructed in Ottawa (located at a latitude of 45° N). The house will have clear glazing and will be cooled during summer months. Determine the noon sun angles for December 21st (winter) and June 21st (summer)

Solution:

→ On December 21st (winter)

Noon sun angle = 90° – (45°N – (- 23.5°S)= 21.5°

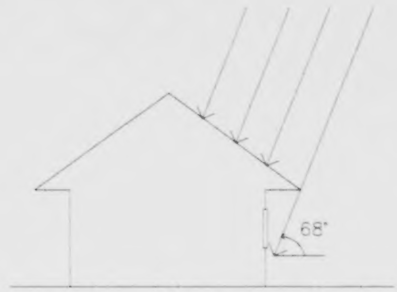


WINTER NOON SUN
ANGLE FOR OTTAWA

→ If the windows will be unshaded when the sun is at 21.5° above the horizon (noon sun angle on December 21st), then the surface is considered to be unshaded and the solar heat can be counted.

→ On June 21st (summer)

Noon sun angle = 90° – (45°N – 23.5°S) = 68°



→ South facing windows in an air conditioned building must be shaded to be protected from the sun when it is at an angle of 68° above the horizon (June 21st)

STOP

COMPLETE THE NEXT FOUR EXERCISES

EXERCISE 3-7

The figures below represent a section view of the south elevation of a 1 storey house showing the sun at the summer noon sun angle. The house will be cooled during summer months, and windows are unshaded in the winter. There will be a forced air system capable of distributing the solar heat gain throughout the building.

Which of the following solar shading designs will permit the area of glazing on the south elevation to be 50% of its area when calculating the maximum glazing area?

(a) All of designs (a), (b) or (c)

(b) Either design (a) or (c)

(c) Either design (a) or (b)

(d) Either design (b) or (c)

Code Ref.:______________________________

EXERCISE 3-8

A new 1 storey Part 9 residential building in Ottawa will have a forced air heating system, and will not be cooled during the summer.

The building is 10 m wide, 20 m deep, and 3 metres high. The south wall will have a total glazing area of 50 m^2. The windows are not shaded in winter. Is this glazing area permitted if the glazing has a shading coefficient of 0.71?

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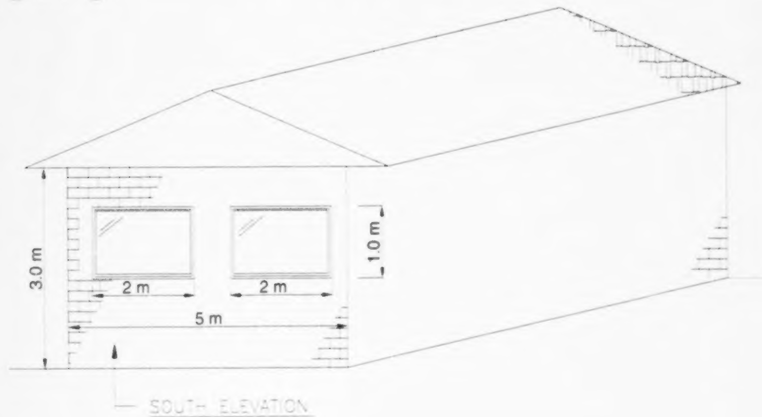
Code Ref.:_____________________________________

EXERCISE 3-9

A new house has two large south-facing windows with clear glazing of 2 m long by 1.0 m high that are unshaded in winter and has a system capable of distributing the solar heat gain throughout the building. The house is not air-conditioned. What area of glazing do these windows contribute to the total area of glazing?



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EXERCISE 3-10

The same house in the exercise above will be constructed with an air-conditioning system. What exterior building features need to be provided so that the total glazing area can be decreased to apply the credit for solar heat gain?

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Code Ref.:________________________________

STOP

THERMAL RESISTANCE REQUIREMENTS FOR DOORS

Table 12.3.3.3. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" does not include minimum thermal resistance values for doors.

Sentence 12.3.3.12.(3) references Article 12.3.2.7. and 12.3.2.8. to determine the minimum thermal performance requirements for doors that separate a heated space from an unheated space. Articles 12.3.2.7. and 12.3.2.8. are also applicable to the thermal insulation compliance option described Module 2.

As seen in Module 2, Sentence 12.3.2.7.(1) is applicable to all doors that separate heated space from the outside, except doors on enclosed unheated vestibules and cold cellars or where storm doors are provided. As per Sentence 12.3.2.7.(1), the non-glazed portion of doors are required to have a minimum thermal resistance of not less than RSI 0.7.

In addition to the minimum thermal performance requirements, the thermal design compliance option has minimum infiltration rates for doors that are described in the following Section in this module.

IMPACT OF ELECTRIC SPACE HEATING

The requirements for thermal resistance of windows and sliding doors are more stringent where electric space heating is used in **dwelling units**.

Division A, Article 1.4.1.2. defines a dwelling unit as:

> *...a suite operated as a housekeeping unit, used or intended to be used as a domicile by one or more persons and usually containing cooking, eating, living, sleeping and sanitary facilities.*

Sentence 12.3.2.8.(2) sets the minimum requirements for windows that separate unheated spaces (or the outdoors) from spaces with electric space heating is used. Windows and glazing must meet one of the following:

- Maximum overall coefficient of heat transfer: 1.6 W/m^2C,

  OR

- Minimum energy rating of 25 (operable windows or sliding glass doors) and 35 (fixed windows).

Sentence 12.3.2.8.(1) sets the minimum requirements for sliding doors where electric space heating is used. Sliding glass doors must meet one of the following:

- Maximum overall coefficient of heat transfer: 1.6 $W/m^{2\circ}C$,

  OR

- Minimum energy rating of 25.

STOP

COMPLETE THE NEXT TWO EXCERCISES

EXERCISE 3-11

A new house is being designed with electric space heating. What is the maximum overall coefficient of heat transfer for sliding doors separating an exterior patio from the interior of a house?

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Code Ref.:________________________________

EXERCISE 3-12

A new 3 storey condominium, having a footprint area of 500 m^2, is being designed with electric space heating. What is the minimum energy rating for operable windows forming part of an exterior wall in each of the individual units?

(a) 25

(b) 35

(c) 17

(d) 27

Code Ref.:________________________________

STOP

AIR INFILTRATION

Air infiltration is the ingress of air through building assemblies acting as environmental separators through cracks or other openings around windows or doors.

One way air is forced through these openings is by pressure differences caused by wind or due to stack effect.

As per Division A, Table 3.2.1.1. "Functional Statements", and Table 12 of SA-1 "Objectives and Functional Statements Attributed to the Acceptable Solutions in Part 12 of Division B", the functional statements associated with the requirements for air infiltration around windows, doors, and sliding doors are:

- *"To Limit drafts" [Functional Statement F54]; and*
- *"To resist the transfer of air through environmental separators" [Functional Statement F55].*

AIR INFILTRATION REQUIREMENTS

Maximum air infiltration rates for windows, doors, and sliding glass doors are set out in Division B, Sentences 12.3.3.13.(1) to 12.3.3.13.(4).

The table below includes the maximum permitted air infiltration rates for assemblies separating heated spaces from unheated spaces.

Maximum Air Infiltration Rates Forming Part of Sentences 12.3.3.13. (1) to (4)

Assembly	Maximum air infiltration rates
Windows	0.775 L/s per metre of sash crack
Manual operating exterior sliding glass doors	2.5 L/s per m^2 of door area
Exterior swing type doors for dwelling units and hotel rooms	6.35 L/s per m^2 of door area
All other doors	17.0 L/s per metre of sash crack

The air infiltration rates for windows, doors, and sliding doors are determined when they are tested at a pressure differential of 75 Pa using the ASTM E283 Standard "Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen".

The air infiltration rates determined using ASTM E283 (usually available from the door or window manufacturer) must not be greater than the above-specified rates.

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 3-13

A window opening for a Part 9 residential building is 1.5 m high by 0.5 m wide. A casement (swing out) operable window is being considered for this opening, such that the operable portion of the window will make up the entire window opening. A casement window manufacturer provides evidence that their window has an air leakage rate of 3.0 L/s for this size of window, when tested in accordance with ASTM E283. Does this proposed window meet the requirement of 12.3.3.13?

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STOP

EXCEPTIONS TO AIR INFILTRATION REQUIREMENTS

The maximum air infiltration rates set out in Sentences 12.3.3.13.(1) to 12.3.3.13.(4) do not apply to the following doors:

- *"Doors used primarily to facilitate the movement of vehicles or handling of material..."* [Sentence 12.3.3.12.(2)] such as overhead garage doors for houses
- *"Doors on enclosed unheated vestibules..."* [Sentence 12.3.3.12.(3)] such as doors to unheated porches
- Exterior swing type doors *"that are weather-stripped on all edges and protected with a storm door..."* [Sentence 12.3.3.13.(3)]
- Exterior swing type doors *" that are weather-stripped on all edges and ...protected by an enclosed unheated space..."*[Sentence 12.3.3.13.(3)]

Doors that are described above are not required to meet any maximum air infiltration rate and are not required to be tested in accordance with ASTM E283.

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 3-14

What are the maximum air infiltration rates for the following building assemblies when applying the thermal design compliance option to a Part 9 residential building? Indicate the units of measurement for the air infiltration rates.

Building Assembly	Air Infiltration Rate	Code Ref.
Sliding glass door (manually operated) separating a kitchen from the exterior		
Operable windows installed in exterior walls		
Building entrance door separating the interior space from the exterior.		
Exterior door that separates an enclosed storage garage and the building.		
Junction between the sill plate and the foundation wall		

STOP

CAULKING MATERIAL REQUIREMENTS

Where caulking is applied to limit the infiltration of air from the exterior to the interior of a Part 9 residential building, the material used as caulking is required to meet the minimum requirements set out in Subsection 9.27.4., as referenced by Sentence 12.3.3.13.(5).

Article 9.27.4.2. requires that caulking materials have the following characteristics:

- non-hardening type suitable for exterior use
- resist the effects of weathering

AND

- compatible and adhere to the substrate to which it is applied

Additionally, caulking materials must meet the requirements of specific CGSB and CAN/CGSB standards, as set out in Sentence 9.27.4.2.(2).

APPLICATION OF AIR BARRIER REQUIREMENTS

The air barrier system for a Part 9 residential building must be installed per Subsection 9.25.3, as referenced by Sentence 12.3.3.13(7).

An air barrier resists the transfer of air through a building assembly.

An air barrier system is required in a Part 9 residential building where service penetrations pass through an assembly separating a heated space from a roof or attic space.

Openings through the air barrier such as for electrical boxes, electrical wiring, or plumbing installations provide opportunities for air leakage into concealed spaces. These openings must be as airtight as possible.

Airtight elements may include:

- Gypsum board sealed by caulking, gaskets, tape, etc.

OR

- Continuous air barrier system (e.g. sheet of polyethylene)

The air barrier system must be installed per Subsection 9.25.3, as referenced by Sentence 12.3.3.13(7).

Openings through the air barrier such as for electrical boxes, electrical wiring, or plumbing installations provide opportunities for air leakage into concealed spaces. These openings must be as airtight as possible.

STOP

EQUIPMENT EFFICIENCY FOR PART 9 RESIDENTIAL BUILDINGS

In addition to the thermal insulation compliance option requirements for energy efficiency, all Part 9 residential buildings are required to meet minimum furnace efficiencies.

The minimum furnace fuel utilization efficiency requirements are set out in Article 12.3.1.2. The efficiency requirements are based on the fuel source of the furnace.

Refer to Module 2 for an example on the application of Article 12.3.1.2.

END

MODULE 4

PART 9 RESIDENTIAL
NRCAN ENERGUIDE COMPLIANCE OPTION

TABLE OF CONTENTS

INTRODUCTION

This module describes how NRCan "EnerGuide for New Houses: Administrative and Technical Procedures" may be used as an option to meet the minimum performance requirements for energy efficiency in Part 9 residential buildings up to December 31, 2011 and will be used as the measure for energy efficiency of these buildings after December 31, 2011.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the rating system for NRCan "EnerGuide for New Houses"
- Identify the factors that influence the performance level of "EnerGuide for New Houses" rating

READ TO THE NEXT STOP.

APPLICATION OF NRCAN ENERGUIDE TO PART 9 RESIDENTIAL BUILDINGS UP TO DECEMBER 31, 2011

Sentence 12.2.1.1.(3) sets out the minimum requirements for Part 9 residential buildings relative to energy efficiency. **Three different compliance options** are offered so that a designer can choose any option to meet the minimum energy efficiency requirements. As per Division B, Sentence 12.2.1.1.(3), any <u>one</u> of clauses (a), (b), or (c) can be applied:

Division B, Sentence 12.2.1.1.(3)

The energy efficiency of a building or part of a building of residential occupancy that is within the scope of Part 9 and is intended for occupancy on a continuing basis during the winter months shall,

(a) Conform to the thermal insulation requirements of Subsection 12.3.2.

(b) Conform to the thermal design requirements of Subsection 12.3.3.

OR

(c) Provide a rating of 80 or more when evaluated in accordance with NRCan 'EnerGuide for New Houses: Administrative and Technical Procedures'

If a building permit application has been made up to December 31, 2011, one way a designer **can meet** the minimum energy efficiency requirements is by demonstrating that the Part 9 residential building has a performance level greater or equal to a rating of 80 when evaluated in accordance with NRCan "EnerGuide for New Houses: Administrative and Technical Procedures".

All applications for Part 9 residential buildings permits submitted after December 31, 2011 will be **required** to demonstrate that they have the performance level that would be achieved by a rating of 80 or more when evaluated in accordance with NRCan "EnerGuide for New Houses".

ENERGY EFFICIENT DESIGN FOR PART 9 RESIDENTIAL BUILDINGS AFTER DECEMBER 31, 2011

After December 31, 2011, new residential buildings within the scope of Part 9 must meet the performance level that is representative of a rating of 80 or more when evaluated in accordance with the NRCan "EnerGuide for New Houses: Administrative and technical Procedures". A building with a label indicating a rating of 80 or more will demonstrate this requirement, however, it is not necessary to obtain a label in order to demonstrate equal performance.

A technical evaluation will be required to be undertaken by a knowledgeable person to compare the performance of a design of a Part 9 residential building design against the criteria and relative performance that would be demonstrated by the EnerGuide label.

NRCAN ENERGUIDE RATING SYSTEM

The NRCan "EnerGuide for New Houses" rating is a guide used to evaluate the energy efficiency of a building.

If applying the NRCan "EnerGuide for New Houses" labeling system to meet the minimum requirements for energy efficiency of new Part 9 residential building, the new building having a rating of 80 shall be deemed to be in compliance with the Building Code.

When applying the NRCan "EnerGuide for New Houses", the rating system of a Part 9 residential building is evaluated on a logarithmic scale from 0 to100, where:

- A rating of 0 represents major air leakage, no insulation and extremely high energy consumption.

- A rating of 100 represents a building that is air tight, well insulated and sufficiently ventilated that requires no net purchased energy, and is completely energy self-sufficient (e.g. uses solar, wind or other renewable energy sources).

Figure 4- 1 NRCan EnerGuide Energy Rating

The following table outlines typical rating ranges:

EnerGuide Rating Chart	
Type of Building	**Rating**
Typical modern building	66 to 74
Energy-efficient modern building (e.g. A 2006 Building Code compliant house, up to December 31, 2011)	75 to 79
Highly energy-efficient modern building	80 to 90
An "advanced building" that uses little or no purchased energy	91 to 100

STOP

EXERCISE 4-1

A design for a 150 m^2, 3 storey house is currently being undertaken. The building permit application will be submitted in 2008. The design will achieve a performance level equal to a rating of 80 if it was evaluated in accordance to NRCan "EnerGuide for New Houses: Administrative and Technical Procedures"

Will the building meet the minimum energy efficiency design requirement?

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Code Ref.: ______________________________

STOP

FACTORS INFLUENCING THE OVERALL ENERGY EFFICIENCY WHEN EVALUATED IN ACCORDANCE WITH ENERGUIDE

An NRCan EnerGuide rating and label for a new Part 9 residential occupancy is dependent on building characteristics and on an energy simulation. Building characteristics which affect the overall energy efficiency of the building include:

- Direction and angle the building faces (e.g. south, north etc.)
- Insulation levels
- Heating and ventilation equipment (e.g. furnace)
- Building envelope (e.g. windows and doors)

Note that the energy simulation that is part of the NRCan "EnerGuide for New Houses" labeling program does not consider the occupants' energy-using habits and efficiency of general appliances. Also, the modeling software makes some assumptions when determining the EnerGuide rating. Assumptions include:

- Number of occupants (4 occupants)
- Thermostat setting (21°C main floors, 19°C for basements)
- Hot water consumption (225 litres/day)
- Lighting and appliance electricity consumption (24 kW/day)
- Monthly average ventilation rate (0.35 air change/hour during the heating season)

The energy simulation is an estimation of the combined energy use of various features in a Part 9 residential building or house, such as:

- heating
- ventilation
- hot water
- lighting fixtures or equipment.

The simulation results for the building represent the performance of the building as a complete system. Accordingly, the relatively poor performance of one particular element can be offset by an exceptional performance of other elements.

EQUIPMENT EFFICIENCY FOR PART 9 RESIDENTIAL BUILDINGS

In addition to the NRCan EnerGuide compliance option for energy efficiency, all Part 9 residential buildings are required to meet minimum furnace efficiencies.

The minimum furnace fuel utilization efficiency requirements are set out in Article 12.3.1.2. The efficiency requirements are based on the fuel source of the furnace.

> Refer to Module 2 for an example on the application of Article 12.3.1.2.

END

MODULE 5

ENERGY EFFICIENCY FOR ALL BUILDINGS OTHER THAN PART 9 RESIDENTIAL BUILDINGS

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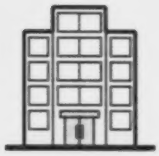

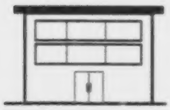

INTRODUCTION

This module describes the minimum requirements for energy efficient design in buildings other than Part 9 residential buildings. Each of the compliance options is discussed and the mandatory dates for transitioning to new provisions are identified.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify the different design options for energy efficient design for buildings other than Part 9 residential buildings up to December 31, 2011
- Identify the different design options for energy efficient design for buildings other than Part 9 residential buildings after December 31, 2011
- Recognize the application and content of Supplementary Standard SB-10
- Recognize the application and content of ANSI/ASHRAE/IESNA 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings"
- Recognize the application and content of the 1997 edition of the "Model National Energy Code Buildings" (MNECB)

READ TO THE NEXT STOP

TRANSITION DATES FOR ENERGY EFFICIENT DESIGNS

Article 12.2.1.1. sets out the minimum requirements for energy efficient designs for all buildings. These provisions are described for two time periods:

- Applications for building permit submitted up to December 31, 2011, where several options are provided, and
- Applications for building permit submitted after December 31, 2011, where only the 1997 edition of the "Model National Energy Code Buildings" (MNECB) + 25% option is available for other than residential buildings.

ENERGY EFFICIENT DESIGN OPTIONS UP TO DECEMBER 31, 2011

For building permit applications submitted up to December 31, 2011, the energy efficient design compliance options are set out in Division B, Sentence 12.2.1.1.(2).

Division B, Sentence 12.2.1.1.(2)

> *Except as provided in Sentences (3) and (5) and permitted in Sentence (4), the energy efficiency of* ***all buildings*** *shall be designed to good engineering practice such as described in,*
>
> *(a) the ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings"* ***and*** *Supplementary Standard SB-10,*
>
> ***or***
>
> *(b) the Model National Energy Code for Buildings* ***and*** *Supplementary Standard SB-10.*

Sentence 12.2.1.1.(2) identifies the 2 compliance options to meet the minimum requirements for energy efficiency for the following buildings:

- Part 3 buildings
- Part 9 non-residential buildings

Additionally, Sentence 12.2.1.1.(4) provides a third compliance option applicable **only to Part 9 non-residential occupancies that do not have electric space heating.**

Part 9 residential buildings are not required to comply with these provisions, however, Sentence 12.2.1.1.(2) requires that all Part 9 residential buildings comply with the provisions of Sentence 12.2.1.1.(3). Sentence (5) **exempts the following buildings** from meeting all energy efficiency requirements:

- Farm buildings;
- Buildings intended primarily for manufacturing or commercial or industrial processing.
- Buildings **not** intended for occupancy on a continuing basis during the winter months.

ENERGY EFFICIENT DESIGN OPTIONS AFTER DECEMBER 31, 2011

Applications for building permit for **all buildings, other than Part 9 residential buildings,** submitted after December 31, 2011 are required to exceed the energy efficiency levels attained by the 1997 "Model National Energy Code for Buildings" (MNECB) by 25%.

EXAMPLE

For building permit applications submitted prior to January 1, 2012, what are the energy efficient compliance options available for Part 3 buildings?

Solution:

→ Sentence 12.2.1.1.(2) sets out the compliance options for all buildings (excluding part 9 residential buildings)

→ Compliance options include one of the following two options:

- Meeting the provisions set out in ANSI/ASHRAE/IESNA 90.1 and SB-10
- Meeting the provisions set out in MNECB and SB-10

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 5-1

What are the energy efficient compliance options for Part 3 buildings and Part 9 non-residential buildings for building permit applications submitted after December 31, 2011?

(a) Provisions set out in ANSI/ASHRAE/IESNA 90.1 and SB-10

(b) Provisions set out in MNECB and SB-10

(c) Exceed the provisions set out in MNECB by 25%

(d) Provisions set out in Division B, Subsection 12.3.4.

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EXERCISE 5-2

What are the energy efficient compliance options for Part 9 non-residential buildings (without electric space heating) if the application for building permit is submitted up to December 31, 2011?

(a) Provisions set out in ANSI/ASHRAE/IESNA 90.1 and SB-10

(b) Provisions set out in MNECB and SB-10

(c) Provisions set out in Division B, Subsection 12.3.4.

(d) Any of the above

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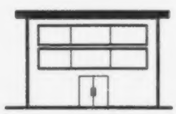
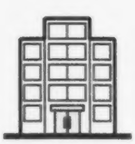
STOP

SUMMARY OF ENERGY EFFICIENCY DESIGN COMPLIANCE OPTIONS

As seen in Module 1, the table below outlines all applicable energy efficiency design compliance options for all buildings other than Part 9 residential buildings.

	Energy Efficiency Design Compliance Option	Applicable up to Dec. 31, 2011	Applicable after Dec. 31, 2011	Code Reference
	ANSI/ASHRAE/IESNA 90.1 and SB-10	✓	--	12.2.1.1.(2)(a)
	MNECB and SB-10	✓	--	12.2.1.1.(2)(b)
	Subsection 12.3.4.	✓	--	12.2.1.1.(4)(a)
	MNECB + 25%	--	✓	12.2.1.2.(2)
	ANSI/ASHRAE/IESNA 90.1 and SB-10	✓	--	12.2.1.1.(2)(a)
	MNECB and SB-10	✓	--	12.2.1.1.(2)(b)
	MNECB + 25%	--	✓	12.2.1.2.(2)

✓ Applicable -- Not Applicable

STOP

SUPPLEMENTARY STANDARD SB-10 "ENERGY EFFICIENCY STANDARD"

The supplementary standard SB-10 includes supplements to ANSI/ASHRAE/IESNA 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings" and 1997 edition of the "Model National Energy Code for Buildings" (MNECB).

When applying either the ASHRAE 90.1 or MNECB, SB-10 should be consulted and applied. The modifications, including additions or substitutions found in the provisions of SB-10 supersede the corresponding provisions in the ASHRAE 90.1 or MNECB.

As per Sentence 12.2.1.1.(2), SB-10 is to be used collectively with either one of the two above-mentioned standards as a compliance option for meeting the minimum energy efficiency requirements for:

- Part 3 buildings, and
- Part 9 non-residential buildings

In addition to the compliance options included in Sentence 12.2.1.1.(2), SB-10 is referenced throughout Part 12 for non-residential buildings.

Some of the Part 12 provisions which reference SB-10 include:

- Thermal bridging concepts for thermal resistance of the building envelope for Part 9 buildings of non-residential occupancy. (Module 6)
- HVAC systems for Part 9 buildings of non-residential occupancy. (Module 9)
- Electric motors for Part 9 buildings of non-residential occupancy. (Module 11)
- Fluorescent lighting ballasts for Part 9 buildings of non-residential occupancy. (Module 12)

SB-10 is organized into 3 chapters with the following general content:

Chapter 1: identifies the application and exemptions common to both ASHRAE 90.1 and the MNECB.

Chapter 2: contains modifications to the ASHRAE 90.1 Standard.

Chapter 3: contains modification to the MNECB.

SB-10 does not apply to the following buildings:

- Part 9 residential occupancy
- Heritage buildings
- Buildings that uses energy at a rate less than $12W/m^2$ under peak conditions
- Temporary structures
- Warehouse or storage areas where the indoor temperature is less than 10°C
- Unheated storage garages, except where conditioned spaces exposed to unheated storage areas.

STOP

ANSI/ASHRAE/IESNA 90.1 "ENERGY STANDARD FOR BUILDINGS EXCEPT LOW-RISE RESIDENTIAL BUILDINGS"

The provisions set out in ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings" and Supplementary Standard SB-10 can be used collectively as a design compliance option for energy efficiency for:

- Part 3 buildings, and
- Part 9 non-residential buildings

For the purpose of applying Division, B Part 12 of the Building Code, ANSI/ASHRAE/IESNA 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings" applies to the following elements of Part 3 buildings, and Part 9 non-residential buildings:

ANSI/ASHRAE/IESNA 90.1

a. *the envelope of buildings, provided that the enclosed spaces are*

   (1) *heated by heating system whose output is greater or equal to 10 W/m² or*

   (2) *cooled by a cooling system whose sensible output capacity is greater than or equal to 15W/m²*

b. *the following systems and equipment used in conjunction with buildings:*

   (1) *HVAC;*

   (2) *Service water heating,;*

   (3) *Electric power distribution and metering provisions;*

   (4) *Electric motors and belt drives; and*

   (5) *Lighting.*

ANSI/ASHRAE/IESNA 90.1 is divided into 12 sections:

- Sections 1, 2, 3, 4 and 12 are administrative
- Sections 5 through 11 are technical and address provisions for building envelope, HVAC, service water heating, power, lighting, and other equipment.

STOP

"MODEL NATIONAL ENERGY CODE FOR BUILDINGS" (MNECB)

The provisions set out in the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) and Supplementary Standard SB-10 can be used collectively as a compliance option for energy efficiency for:

- Part 3 buildings

and

- Part 9 non-residential buildings

The "Model National Energy Code for Buildings" (MNECB) sets out minimum requirements for buildings elements by taking into account regional construction costs, regional heating fuel types and costs and regional climatic differences.

The MNECB includes provisions for:

- building envelope
- water heating
- lighting
- HVAC systems
- electrical power

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 5-3

A 2 storey office building having a footprint area of 500 m^2 is being designed to have electric space heating. The building permit will be submitted in 2008. The designer would like to comply with Subsection 12.3.4. as an alternative to meet the minimum energy efficiency requirements. Is the designer permitted to use Subsection 12.3.4. as a compliance option for energy efficient design?

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EXERCISE 5-4

Consider the same building described in Exercise 5-3, identify all possible compliance options that the designer may follow in order to meet the minimum energy efficiency requirements set out in Part 12?

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END

MODULE 6

PART 9 NON-RESIDENTIAL THERMAL RESISTANCE

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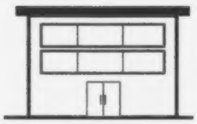
INTRODUCTION



This module describes the provisions for thermal resistance of the building envelope for Part 9 non-residential buildings (without electric space heating). The thermal resistance requirements set out in Subsection 12.3.4. can be used as an alternative to the requirements of SB-10 used in combination with ASHRAE 90.1, or the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) Part 9 non-residential buildings (without electric space heating).

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize and understand the option to apply Subsection 12.3.4 for thermal resistance of building envelopes of Part 9 non-residential buildings (without electric space heating)
- Recognize the limitations of Subsection 12.3.4.
- Determine applicable degree-day zones
- Apply the minimum thermal resistance values of building assemblies set out in Tables 12.3.4.2.A.
- Apply the minimum thermal resistance of insulation for slab-on-ground set out in Table 12.3.4.2.B.

READ TO THE NEXT STOP.

APPLICATION OF THE THERMAL DESIGN OPTION FOR PART 9 NON-RESIDENTIAL BUILDINGS UP TO DECEMBER 31, 2011

As seen in Module 5, Division B, Sentence 12.2.1.1.(4) permits Part 9 non-residential buildings (without electric space heating) to meet the minimum requirements of Subsection 12.3.4. for energy efficiency. Subsection 12.3.4. may be used as a compliance option in lieu of conforming with SB-10 in combination with ASHRAE 90.1 or SB-10 in combination with the MNECB that are otherwise applicable as referenced by Division B, Sentence 12.2.1.1.(2).

Division B, Sentence 12.2.1.1.(4) sets out the limitations of applying Subsection 12.3.4. up to December 31, 2011.

Division B, Sentence 12.2.1.1.(4)

> *The energy efficiency of a building or part of a building may conform to the design requirements of Subsection 12.3.4. if the building or part of the building,*
>
> *(a) is within the scope of Part 9,*
>
> *(b) does not contain a residential occupancy,*
>
> *(c) does not use electric space heating, and*
>
> *(d) is intended for occupancy on a continuing basis during the winter months.*

Article 12.3.4.2 addresses the minimum requirements for thermal resistance of most building assemblies. These will be discussed in this Module.

The energy performance of other building features must be taken into account when applying Subsection 12.3.4. to meet the minimum energy efficient design requirements of Part 9 non-residential buildings (without electric space heating). These features will be discussed in separate modules:

- Window performance (Module 7)
- Air infiltration (Module 8)
- HVAC systems (Module 9)
- Service water heating (Module 10)
- Electric motors (Module 11)
- Lighting (Module 12)

APPLICATION OF THERMAL RESISTANCE REQUIREMENTS

Article 12.3.4.2. sets out the minimum thermal resistance requirements of the building envelope. The thermal resistance requirements take into account the insulating contribution from all elements of the building assembly.

Division B, Sentence 12.3.4.2.(1)

> *Except as permitted in Sentences (2) and (3), the minimum thermal resistance of all walls, ceilings and floors that separate heated space from unheated space, the exterior air or the exterior soil shall conform to Table 12.3.4.2.A.*

Table 12.3.4.2.A. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" sets out the minimum thermal resistance values for building assemblies separating a heated space from an unheated space or the exterior.

Sentence 12.3.4.2.(2) sets out limitations for the application of Table 12.3.4.2.A.,

Sentence 12.3.4.2.(3) refers to Table 12.3.4.2.B. "Minimum Thermal Resistance for Slab-on-Ground" to determine the minimum thermal resistance (RSI) values of insulation applied on slab-on-ground.

STOP

MINIMUM THERMAL RESISTANCE REQUIREMENTS FOR BUILDING ASSEMBLIES

The minimum RSI values for building assemblies set out in Table 12.3.4.2.A "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" must take into consideration all elements of the building assembly, including thermal bridging, except for below-grade walls where the RSI value is only for the insulation.

Table 12.3.4.2.A. includes minimum RSI values for the following building assemblies:

- Opaque wall assembly (an exterior wall assembly exposed to the elements)
- Wall assembly adjacent to unconditioned space (e.g. wall assembly protected from the exterior elements)
- Below grade wall in contact with ground (required RSI values apply to insulation only)
- Roof assembly
- Floor assembly over unconditioned space (interior or exterior)

Each building element (such as insulation or interior gypsum board or exterior sheathing) contributes to the overall RSI value of the assembly and has its own RSI value. The overall RSI value of the building assembly is the sum of the RSI values of each building element in the building assembly.

The RSI values in Table 12.3.4.2.A "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" take into account each of these elements, with the exception of the **below grade wall,** where the RSI shown in Table 12.3.4.2.A. "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" applies only to the insulation.

Sentence 12.3.4.2.(2) permits **foundation walls** extending less than 1200 mm above the adjacent ground level to have an RSI value corresponding to that of a below grade wall (Figure 6-1).

Division B, Sentence 12.3.4.2.(2)

> *Where the top of a foundation wall is less than 1 200 mm above the adjoining ground level, those portions of the foundation wall that are above ground may be insulated to the level required for the below grade portion of the foundation wall.*

However, if the top portion of the foundation wall is equal or greater than 1200 mm above the adjacent ground level, the foundation wall must have an RSI value corresponding to the RSI value otherwise required for:

- Opaque wall assembly (exposed to the exterior elements)

OR

- Wall assembly adjacent to unconditioned space (protected from the exterior elements)

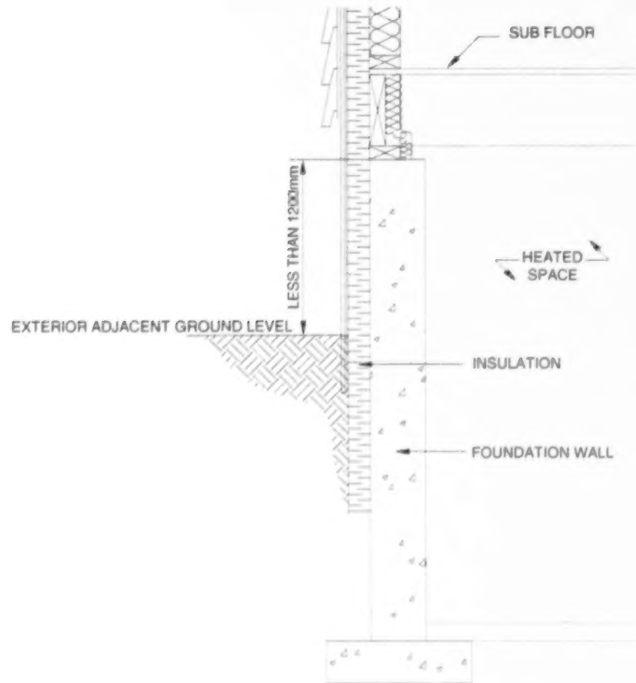


Figure 6- 1 Foundation Wall that can have RSI corresponding to that of a Below-Grade Wall

The minimum required RSI values in Table 12.3.4.2.A "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" are dependant on the location of the building (i.e. town or city).

The town or city is classified into two Zones by considering the heating degree-days of the location of the building.

Zone 1: Heating Degree-days < 5000/year

Zone 2: Heating Degree-days ≥ 5000/year

HEATING DEGREE-DAYS

The minimum RSI values found in Table 12.3.4.2.A "Minimum Thermal Resistance of Building Assemblies Based on Degree-Day Zones" consider the energy required to heat a building, which can be expressed in terms of heating degree-days (HDD).

Except for buildings with electric heat, the amount of energy to heat a building is dependant on the number of heating degree-days found in SB-1, Table 1.2. "Design Data for Selected Locations in Ontario"

The heating degree-days can be found in SB-1, Table 1.2. for specific locations in Ontario.

Refer to Module 2 for additional information regarding Heating Degree-days

EXAMPLE

A new warehouse building (500 m^2) with a natural gas heating system is being designed in Vaughan, Ontario. The application for building permit will be submitted in 2009. Determine the minimum thermal resistance of an exterior wall assembly that does not contain any windows or service penetrations.

Solution:

→ Subsection 12.3.4. is applicable to the new warehouse building.

→ Determine the heating degree-day zone for Vaughan Refer to Table 1.2 in SB-1 "Design Data for Selected Locations in Ontario"

- Vaughan has 4250 annual heating degree-days.
- Vaughan is considered to be in Zone 1 (where Zone 1 is defined as HDD<5000)

→ Determine the minimum thermal resistance value of the exterior wall assembly.

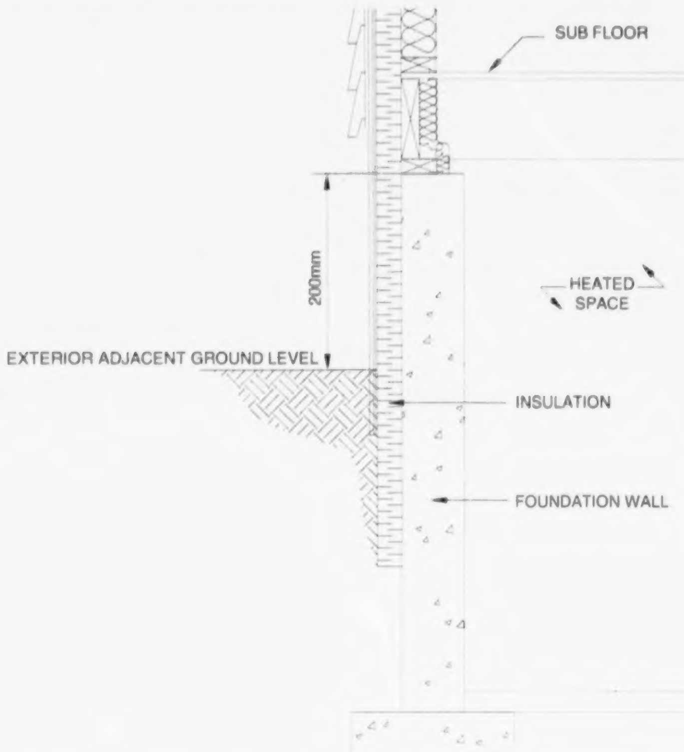
- Refer to Table 12.3.4.2.A for minimum RSI values
- The exterior wall is considered as an opaque wall in Zone 1
- Therefore, the minimum RSI value of the wall is 2.63 $m^{2}°C/W$

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 6-1

The foundation wall below is supporting a small office building located in Sturgeon Falls (without electric heating) having a footprint area of 400 m². What is the minimum thermal resistance of the insulation installed along the foundation wall if the designer is using Subsection 12.3.4. as the energy efficiency compliance option?



(a) 3.83 m²°C/W

(b) 2.11 m²°C/W

(c) 2.02 m²°C/W

(d) 2.82 m²°C/W

____

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STOP

MINIMUM THERMAL RESISTANCE REQUIREMENTS FOR SLAB-ON-GROUND

Division B, Sentence 12.3.4.2.(3) sets out the minimum thermal resistance values (RSI) and the minimum length of insulation for a slab-on-ground.

> *The minimum thermal resistance of a slab-on-ground shall conform to Table 12.3.4.2.B.*

Table 12.3.4.2.B. "Minimum Thermal Resistance for Slab-on-Ground Insulation" is applicable **only** to the **insulation** installed at the edge of the slab-on-ground.

The RSI values only takes into consideration the insulation of the slab-on-ground. They do not consider each element of the slab-on-ground assembly such as the thermal properties of a poured concrete slab.

The insulation applied to the exterior edge of the slab-on-ground is required to be either 600 mm or 1200 mm in length. An increase in insulation length allows for a reduced RSI value.

Also, Table 12.3.4.2.B permits installation variations:

- Vertically (down from the edge of the slab)
- Horizontally (down and outward from the edge of the slab).

The RSI values for insulation installed vertically are less than the RSI values for the same insulation installed horizontally.

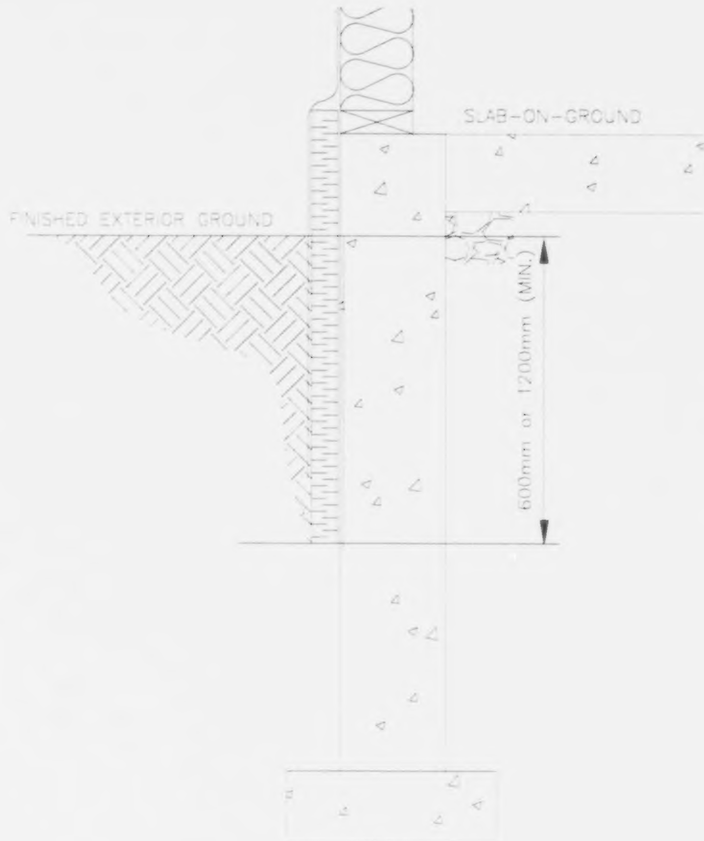
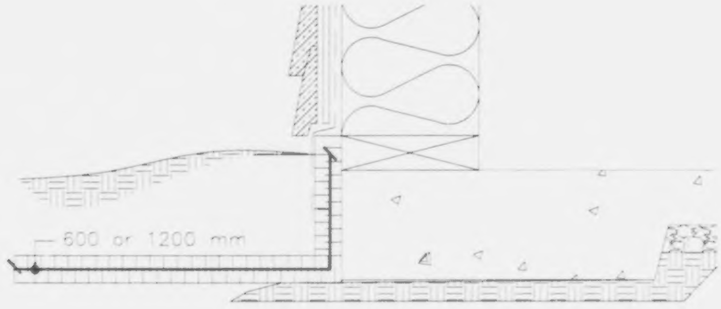
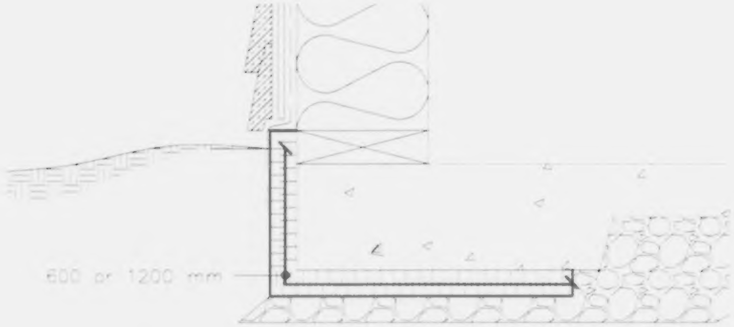


Figure 6- 2 Thermal Insulation Installed Vertically for Slab-on-Ground



(a)



(b)

Figure 6- 3 Thermal Insulation Installed Horizontally for Slab-on-Ground

Note that the structural properties for the insulation should be considered.

The minimum required RSI values in Table 12.3.4.2.B are dependant on:

- Type of slab-on-ground (unheated vs. heated by cables or pipes for radiant heat),
- Position of insulation (vertical/horizontal vs. only vertical), and
- Length of insulation

Where insulation lengths are different from 600 mm and 1200 mm, the minimum RSI values in Table 12.3.4.2.B to be interpolated.

EXAMPLE

An unheated slab-on-ground is designed for a new 1 storey storage garage having a footprint area of 300 m^2. The total length of the insulation is 600 mm. What is the minimum RSI value required for insulation that is applied horizontally if the building permit application is submitted in 2009?

Solution:

→ Subsection 12.3.4. is applicable to the Part 9 non-residential building without electric space heating

→ Refer to Table 12.3.4.2.B.

→ Column 1 is divided by unheated and heated slab-on-ground. Locate unheated slab-on-ground.

→ Column 2 is divided by horizontal and vertical position of insulation. Locate horizontal position of insulation.

→ Column 3 is divided by 600 mm and 1200 mm insulation lengths. Locate a length of 600 mm.

→ Therefore, the minimum thermal resistance value (RSI) for the proposed slab-on-ground is 3.17 $m^2{}^\circ C/W$.

EXAMPLE

Consider the same storage garage described in the previous example, however the total length of insulation is 1000 mm. What is the minimum RSI value required for the insulation that is applied horizontally?

Solution:

→ Subsection 12.3.4. is still applicable to the Part 9 non-residential building.

→ Refer to Table 12.3.4.2.B.

→ Column 1 is divided by unheated and heated slab-on-ground. Locate heated slab-on-ground.

→ Column 2 is divided by horizontal and vertical positions. Locate horizontal position of insulation.

→ Column 3 is divided in 600 and 1200.

→ The proposed insulation is 1000 mm, therefore the minimum RSI value is found by linear interpolation between 1.94 m^2°C/W. and 3.17 m^2°C/W

$$\frac{1200-600}{1.94-3.17}=\frac{1200-1000}{1.94-x}$$

$$600(1.94-x)=-246$$

$$x=2.35\mathrm{m}^2\,{}^\circ\mathrm{C/W}$$

→ Therefore, the minimum RSI value for the proposed insulation is 2.35 m2°C/W.

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 6-2

What is the minimum RSI value for insulation installed vertically along an unheated slab-on-ground having a length of 800 mm when applying the provisions of Subsection 12.3.4.?

(a) 3.52 $m^2 {}^{\circ}C/W$

(b) 2.29 $m^2 {}^{\circ}C/W$

(c) 1.76 $m^2 {}^{\circ}C/W$

(d) 1.17 $m^2 {}^{\circ}C/W$

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EXERCISE 6-3

An unheated slab-on-ground is designed for a new 3 storey office having a footprint area of 400 m^2. The building is heated with natural gas. The total length of the insulation is 600 mm. What is the minimum RSI value required for insulation that is applied vertically if the building permit application is submitted in 2009?

(a) 0.70 $m^2 {}^{\circ}C/W$

(b) 1.06 $m^2 {}^{\circ}C/W$

(c) 1.41 $m^2 {}^{\circ}C/W$

(d) 1.76 $m^2 {}^{\circ}C/W$

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END

MODULE 7

PART 9 NON-RESIDENTIAL WINDOW PERFORMANCE

RESOURCE CONSERVATION ALL BUILDINGS – 2006

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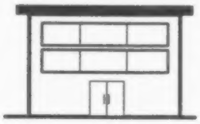
INTRODUCTION



This module describes how the minimum performance requirements for windows can be used as an alternative to the requirement to comply with ASHRAE 90.1 and SB-10, or the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) for Buildings and SB-10 for Part 9 non-residential buildings without electric space heating.

Participants are given the opportunity to carry out calculations to determine the minimum performance requirements for windows that will limit energy consumption of Part 9 non-residential buildings without electric space heating.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Calculate window-to-wall ratio
- Identify maximum overall coefficient of heat transfer required for windows

READ TO THE NEXT STOP

HEAT TRANSFER FOR WINDOWS

Heat transfer takes place through all windows that separate heated spaces from unheated spaces. Glass absorbs heat energy from its surroundings, and transfers it into an adjacent cooler environment. This heat transfer increases energy consumption because the heating system must compensate for the heat loss through windows during winter months.

The minimum performance requirements do not address heat gain through the windows during summer months.

MINIMUM WINDOW PERFORMANCE

The window performance requirements set out in Sentence 12.3.4.2.(4) are an alternative to ASHRAE 90.1 and SB-10, and MNECB and SB-10 for Part 9 non-residential buildings without electric space heating.

Division B, Sentence 12.3.4.2.(4)

> *The maximum overall coefficient of heat transfer for windows that separate heated space from unheated space shall conform to Table 12.3.4.2.C.*

Table 12.3.4.2.C. applies only to windows installed in walls that separate a heated space from an unheated space for all Part 9 non-residential buildings (without electric space heating).

The minimum window performance is assessed based on the overall coefficient of heat transfer and is dependant on the window-to-wall ratio (discussed below).

Generally, manufacturers provide the U-Value for windows. It is important when comparing the U-Value to the maximum overall coefficient of heat transfer that the values are represented with the same units.

Refer to Module 2 for further discussion on the different measures of thermal performance

STOP

WINDOW-TO-WALL RATIO

The area of glazing in an exterior wall will impact the amount of heat transfer from the warmer environment to the cooler environment.

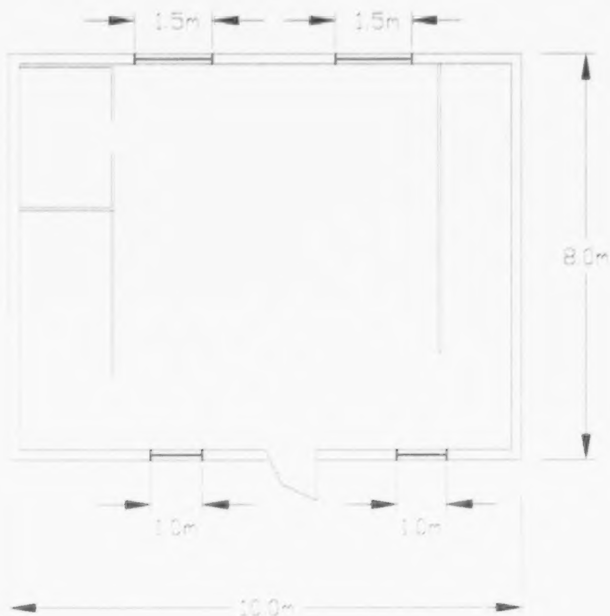
The window performance with respect to heat transfer is dependant on the window-to-wall ratio:

Window-to-wall ratio = Glazing area ÷ Gross Wall area

EXAMPLE

A plan for a small store (8 m deep, 10 m wide, 3 m high) is showing the following glazing, where all windows are 2 metres in height. The door does not have any glazing.

Determine the window-to-wall ratio for the store.



Solution:

→ Total window area

- 2(1.5 m x 2 m)= 6 m^2
- 2 (1 m* 2 m)= 4 m^2
- 10 m^2

→ Total wall area

- 2(8 x 3)= 48 m^2
- 2(10 x 3) = 60 m^2
- 108 m^2

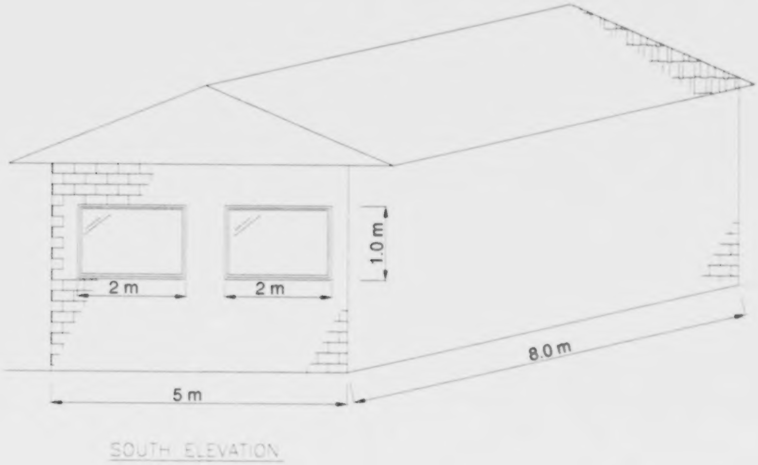
→ Window-to-wall ratio

- 10 ÷ 108 = 0.09

COMPLETE THE NEXT EXERCISE

EXERCISE 7-1

What is the window-to-wall ratio of the building illustrated below? The building has a rectangular foot print area and windows are only installed on the south elevation.



(a) 0.50

(b) 0.27

(c) 0.05

(d) 0.72

STOP

EXAMPLE

Consider the same building described in the first example on Page 7.3. Determine the maximum required coefficient of heat transfer for all windows.

Solution:

Maximum required coefficient of heat transfer:

- The window-to-wall ratio was determined to be 0.09
- Referring to Table 12.3.4.2.C, the maximum coefficient of heat transfer is 3.01 W/m2°C.

COMPLETE THE NEXT EXERCISE

EXERCISE 7-2

A designer is permitted to apply the provisions of Subsection 12.3.4. to meet the minimum energy efficiency requirements. A new building will have a square foot print area of 100 m^2 and a wall height of 3 metres. The designer is proposing full height glazing on the entire back wall and two 4 m^2 windows in the front wall. What is the maximum permitted coefficient of heat transfer for all windows.

(a) 3.01 $W/m^2°C$

(b) 2.28 $W/m^2°C$

(c) 1.70 $W/m^2°C$

(d) Maximum coefficient of heat transfer is not required

Code Ref.:______________________________

END

MODULE 8

PART 9 NON-RESIDENTIAL
AIR INFILTRATION

RESOURCE CONSERVATION ALL BUILDINGS – 2006

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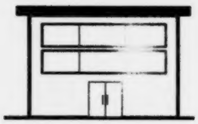


INTRODUCTION

This module focuses on how designing against air infiltration can increase energy efficiency and contribute to limiting energy consumption in Part 9 non-residential buildings without electric space heating.

The maximum air infiltration rates discussed in this module can be used as an alternative to the application of SB-10 in combination with either ASHRAE 90.1 or the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) for Part 9 non-residential buildings without electric space heating.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Recognize the importance of an air barrier
- Identify the requirements for an air barrier system
- Recognize the cross references to Part 5 for air barrier systems
- Recognize the cross references to Part 9 for air barrier systems

READ TO THE NEXT STOP

APPLICATION OF AIR BARRIER REQUIREMENTS

Article 12.3.4.3. sets out the minimum requirements for air barriers for Part 9 non-residential buildings without electric space heating.

To resist the transfer of air through a building assembly, an air barrier system is required for an insulated building assembly that separates interior space from exterior spaces.

The following illustrations are examples of good practice of air barrier systems.

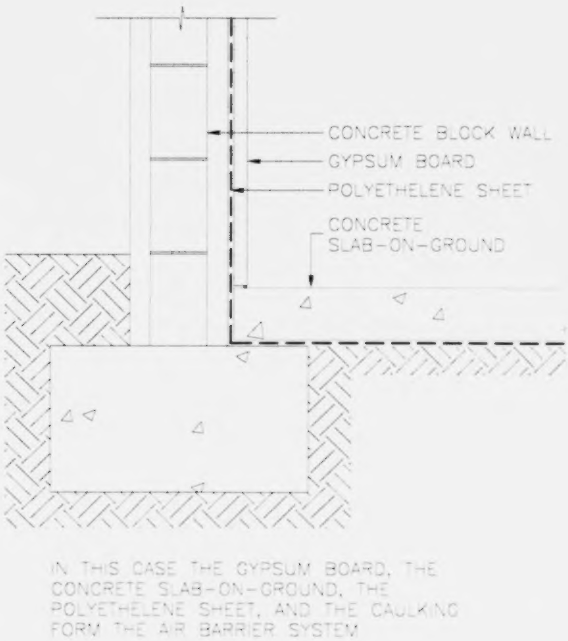


Figure 8- 1 Air barrier System Separating Interior Space from Ground

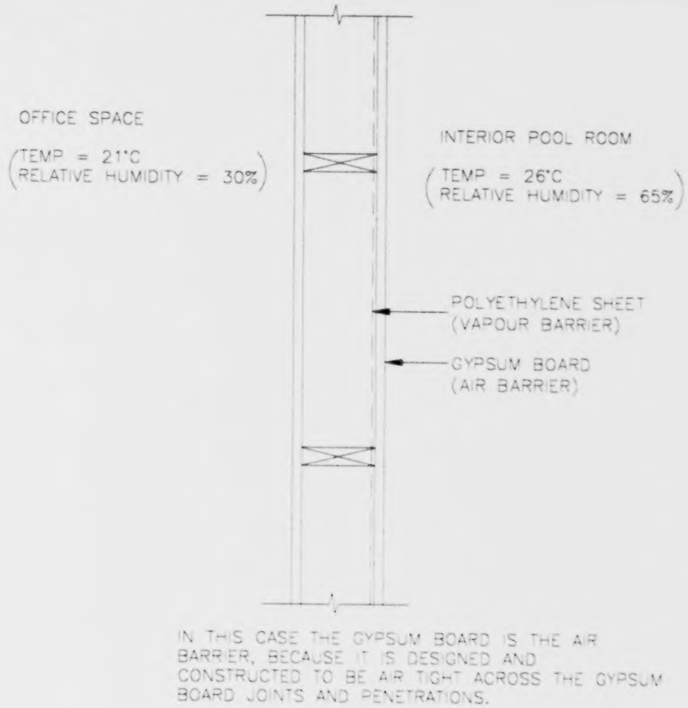


Figure 8- 2 Air Barrier System Separating Dissimilar Interior Spaces

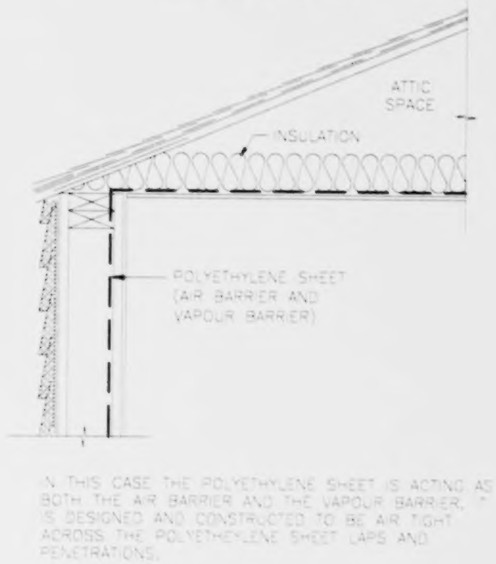
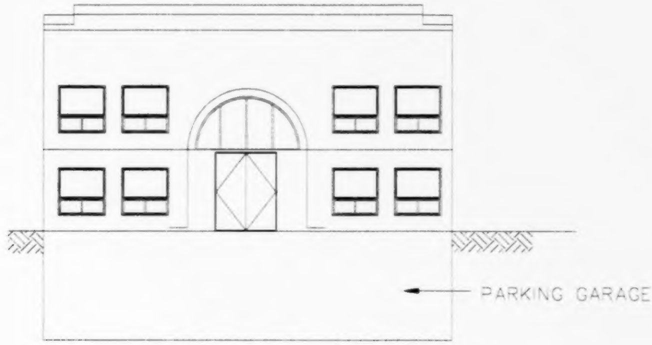


Figure 8- 3 Air Barrier System Separating Interior Conditioned Spaces from Exterior

EXAMPLE

A new office building is being designed. The building will be 2 storeys in building height and will be constructed above a parking garage (1 storey below grade). Which of the following building assemblies will be required to include an air barrier system?



a) Exterior wall assembly

b) Partition walls between kitchenettes and office space

c) 2nd floor assembly

d) Ground floor assembly

e) Roof

	Building Assembly	Air Barrier System Required?	Reason
a)	Exterior wall assembly	Yes	Assembly separates a conditioned space from the exterior.
b)	Partition walls between kitchenettes and office space	No	Both interior spaces have similar temperature and moisture conditions
c)	2nd floor assembly	No	Both ground and 2nd floor interior spaces are similar
d)	Ground floor assembly	Yes	The ground floor assembly does act as an environmental separator to the parking garage below. The interior spaces are environmentally dissimilar due to the difference in temperature and humidity
e)	Roof	Yes	Assembly separates a conditioned space from the exterior

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 8-1

A small bank will be constructed as an end unit of a series of units forming a strip mall. The adjacent unit is a warehouse for refrigerated storage. Which of the following building assemblies of the bank is required to include an air barrier system:

(a) Roof assembly

(b) Wall assemblies separating new bank from the public pool.

(c) Slab-on-ground of unit

(d) All of the above

Code Ref.:__________________________________

STOP

CONTINUITY OF THE AIR BARRIER SYSTEM

In addition to the objectives to control air movement for energy conservation, Part 5 and Section 9.25. has added objectives including resisting the ingress of precipitation, water, or moisture from the exterior or from the ground.

As a result, the air barrier system is required to be continuous along the environmental separator.

Division B, Sentence 5.4.1.2.(3)

(a) across construction, control and expansion joints

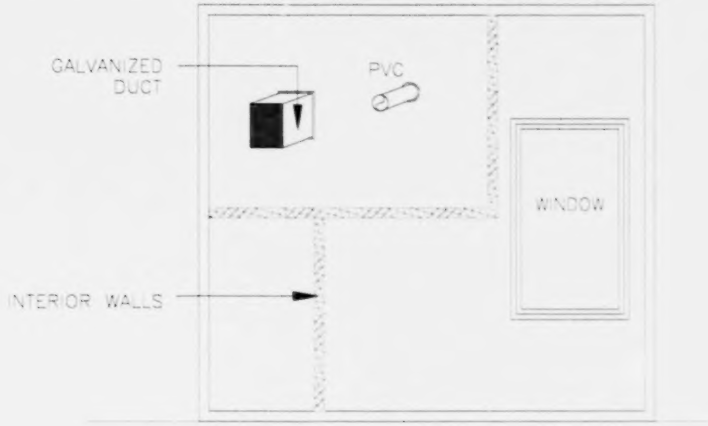
(b) Across junctions, and

(c) Around penetrations

COMPLETE THE NEXT EXERCISE

EXERCISE 8-2

Which of the following gaps are required to be sealed to provide a continuous barrier system?



ELEVATION OF EXTERIOR WALL

(a) Around galvanized duct

(b) around PVC pipe

(c) Around window

(d) All of the above

END

MODULE 9

PART 9 NON-RESIDENTIAL HVAC

RESOURCE CONSERVATION ALL BUILDINGS – 2006

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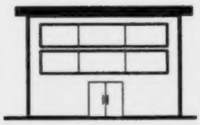

INTRODUCTION

This module describes how the efficiency of heating, ventilation, and air-conditioning systems (HVAC) for Part 9 non-residential buildings without electric space heating can support resource conservation objectives.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Apply the requirements for HVAC zone limitations
- Apply SB-10 for energy efficiency in HVAC systems
- Recognize and understand conditions requiring economizers
- Apply conditions for heat recovery ventilators
- Apply conditions for automatic and manual thermostat controls
- Apply insulation requirements for ducts, plenums and piping

READ TO THE NEXT STOP

ZONE LIMITATIONS FOR HVAC SYSTEMS

Generally, HVAC systems serving **multiple zones** are required to meet Supplementary Standard SB-10 in combination with ANSI/ASHRAE/IESNA 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings" or the 1997 edition of the "Model National Energy Code for Buildings" (MNECB), as per Sentence 12.3.4.4.(1).

Otherwise, as per Sentence 12.3.4.40.(2), building permit applications submitted up to December 31, 2011 for Part 9 non-residential buildings (without electric space heating) are permitted to meet the requirements of Sentences 12.3.4.4.(4) to (11), and Article 12.3.4.5. in addition to the requirements set out in SB-10 as per Sentence 12.3.4.4.(2) for HVAC systems serving a **single zone**.

Division B, Sentence 12.3.4.4.(2)

> *Sentences (3) to (11) and Article 12.3.4.5. apply to a heating, ventilating and air-conditioning system that serves a single heating, ventilating and air-conditioning zone.*

An HVAC zone of a building is a volume of space that has common temperature conditions and a similar contribution of thermal loads from all elements such as roof, walls, windows, lighting, shading and equipment that may contribute to temperature variations within a floor area. A zone also has a common occupant density and ventilation requirements. A single zone is often controlled by a single thermostat.

For example, a floor area of office occupancy will be a different HVAC zone from that of an adjacent conference facility due to different occupant densities. Also, the top floor of an office building will be a different HVAC zone from a lower floor that does not have the heat losses through the roof, as does the top floor.

ENERGY EFFICIENCY OF HVAC SYSTEMS

The Supplementary Standard SB-10 sets the minimum performance requirements for new HVAC equipment. The energy efficiency of new HVAC equipment is required to meet the provisions set out in SB-10.

Where an HVAC system serves more than a single zone, the HVAC system must comply with the requirements set out in:

- ANSI/ASHRAE/IESNA 90.1

or

- the "Model National Energy Code for Buildings" (MNECB)

The actual efficiency of the equipment must satisfy the minimum requirements set in SB-10, Tables 6.8.1A to 6.8.1G.

SB-10 is used to determine the minimum efficiency value for the following:

- Electrically operated unitary air conditioners and condensing units [Table 6.8.1A]
- Electrically operated unitary and applied heat pumps [Table 6.8.1B]
- Water chilling packages [Table 6.8.1C]
- Packaged terminal air conditioners and heat pumps, single-package vertical air conditioners and heat pumps, and room air conditioners and heat pumps [Table 6.8.1D]
- Furnaces and unit heaters [Table 6.8.1E]
- Gas-fired and oil-fired boilers [Table 6.8.1F]
- Cooling tower performance [Table 6.8.1G]

The actual efficiency of the equipment is found when tested in accordance with the specified test procedure that is referenced in the applicable SB-10 table.

Note: Equipment covered under the Ontario Energy Efficiency Act are required to comply with the Ontario Ministry of Energy certification requirements.

EXAMPLE

What is the expression representing the minimum efficiency requirement for a gas-fired boiler having a capacity of 500 kW serving a single HVAC zone?

Solution:

→ SB-10 requirements are applicable to HVAC systems serving a single zone.

→ Table 6.8.1F in SB-10 sets out the expressions for the minimum requirements for boilers

→ Minimum efficiency = 75% x E_t

Note: E_t is the thermal efficiency of the boiler.

COMPLETE THE NEXT EXERCISE

EXERCISE 9-1

What is the expression representing the minimum efficiency requirement for an oil-fired warm air furnace having a capacity of 200,000 Btu/h serving a single HVAC zones?

(a) 81% Et

(b) 78% SEUE

(c) 78% AFUE

(d) none of the above

Code Ref.:______________________________

STOP

USE OF ECONOMIZERS

Air economizers are used to limit excessive energy consumption and to maintain appropriate indoor/outdoor air pressure differences.

Economizer systems take advantage of favourable weather conditions to reduce mechanical cooling. During cooling season, if there is cool, dry air outside, it will be drawn into the building to decrease its ambient temperature, instead of using chillers to provide cooling.

ECONOMIZER REQUIREMENTS SERVING A SINGLE HVAC ZONE

Sentence 12.3.4.4.(4) and (5) set out the minimum requirements for the economizers serving a single HVAC zone.

Division B, Sentence 12.3.4.4.(4)

> *An air-conditioning system with a cooling capacity of 40 kW or more shall have an economizer,*
>
> (a) *controlled by appropriate high limit shut-off control, and*
>
> (b) *equipped with either barometric or powered relief sized to prevent excess pressurization of the building.*

As per Sentence 12.3.4.4.(5), blade and jam seals are required for an outdoor air damper serving an economizer.

STOP

REQUIREMENTS FOR HEAT RECOVERY VENTILATORS SERVING A SINGLE HVAC ZONE

A heat recovery ventilator system allows buildings to maintain high indoor air quality without excessive additional energy costs.

As per the requirements of Sentence 12.3.4.4.(6), a heat recovery ventilator having a recovery effectiveness of at least 50% (at the outside winter design temperature) is required where the quantity of the outdoor air supplied to the distribution system is as follows:

Sentence 12.3.4.4.(6)

(a) more than 1 400 L/s, and

(b) more than 70% of the supply air quantity of the system.

As per Sentence 12.3.4.4.(7), the heat recovery system is required to have bypass or control features that will permit the use of the air economizer.

COMPLETE THE NEXT EXERCISE

EXERCISE 9-2

Which of the following requires a heat recovery ventilator, as per Sentence 12.3.4.4.(6)?

System	Yes	No	Code Ref.
Example: HVAC system serving two zones, where the outdoor air supplied is: - 1000 L/s, and - 80% of the supply air of the system		✓	Sentence 12.3.4.4.(2)
HVAC system serving two zones, where the outdoor air supplied is: - 1500 L/s, and - 80% of the supply air of the system			
HVAC system serving a single zones, where the outdoor air supplied is: - 1000L/s, and - 80% of the supply air of the system			
HVAC system serving a single zones, where the outdoor air supplied is: - 1500 L/s, and - 80% of the supply air of the system			

STOP

MANUAL AND AUTOMATIC THERMOSTAT CONTROLS SERVING A SINGLE HVAC ZONE

To maintain appropriate indoor air temperatures, Division B, Sentence 12.3.4.4.(8) requires the following:

Division B, Sentence 12.3.4.4.(8)

> *A heating, ventilating and air-conditioning system shall be controlled by a manual changeover or dual setpoint thermostat.*

Additionally, a time clock is required by Division B, Sentence 12.3.4.4.(9) for an HVAC system having a capacity greater than 4.4 kW and a supply fan rated for more than 0.5 kW.

The time clock must have the following control features:

- Capability to setback down the minimum temperature to 13°C during off-hours
- Capability to setup maximum temperature to 32°C during off-hours
- Capable of controlling the system for 7 different day types per week
- Capable of retaining programmed settings for a period of at least 10 hours during loss of power
- Manual override for up to 2 hours of temporary operation

COMPLETE THE NEXT EXERCISE

EXERCISE 9-3

A time clock is being proposed. Identify whether or not the following features comply with Sentence 12.3.4.4.(9).

Feature	Complies	Does not Comply	Code Ref.
Example: Set a maximum temperature of 30°C during off-hours		✓	Clause 12.3.4.4.(9)(e)
Capable of programming for 7 day types/week			
Set a minimum temperature of 10°C during off hours.			
Manual override that allows for temporary operation for up to 5 hours.			
Retains all settings for a period of 5 hours during loss of power.			

STOP

REQUIREMENTS FOR SEALING DUCTS AND PLENUMS SERVING HVAC

Sealing ducts to limit air leakage is described according to class seal levels. The class seal levels are dependant on the type of duct or plenum. Both the class seal levels and the type of duct or plenum are defined in SMACNA's "HVAC Duct Construction Standards Metal and Flexible".

Class Seal Level
SMACNA "HVAC Duct Construction Standards Metal and Flexible"

Seal Class	Applicable Sealing
A	All joints, seams, and wall penetrations
B	Transverse joints and seams
C	Transverse joints

As per Division B, Sentence 12.3.4.5.(1), a duct or a plenum that is not protected by an insulated wall or is located in an unheated space is required to be:

- Sealed to a Class A seal level

AND

- Insulated to provide a thermal resistance value (RSI) of 1.4

Otherwise, as per Sentence 12.3.4.5.(2), a duct or plenum located in a conditioned space is required to be sealed to a Class C seal level.

MINIMUM INSULATION REQUIREMENTS FOR DUCTS, PLENUMS, AND PIPING

Table 12.3.4.5. sets the minimum pipe insulation thicknesses for the applicable steam, hot water, or cooling piping that is not within prefabricated equipment. Insulation material is required to have a maximum thermal conductivity of 0.42 W/m°C.

Minimum insulation thicknesses are stipulated for nominal pipe sizes up to and equal to 40 mm and for pipe sizes more than 40 mm.

As required by Division B, Sentence 12.3.4.5.(4) exterior insulated piping, exposed to weather, is required to be covered by:

- Aluminum
- Sheet metal
- Canvas
- Plastic

EXAMPLE

What is the minimum class seal level for a duct located in an unheated storage garage?

Solution:

→ Sentence 12.3.4.5. sets out the requirements for sealing ducts

→ The duct is required to be sealed to a Class A seal level (sealed at all joints, seams, and wall penetrations)

Note: The duct must also be insulated to provide a minimum thermal resistance of 1.4 m^2°C/W.

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 9-4

For the following pipes, what is the minimum thickness of pipe insulation required if the insulation material has a thermal conductivity of 0.40 W/m°C if the piping is not prefabricated and is used for hot water heating?

Pipe Size and Use	Minimum Required Thickness of Pipe Insulation (mm)
2" pipe serving hot water heating	
64 mm pipe serving domestic hot water system	
50 mm pipe serving cooling system	
1" pipe for steam	

Code Ref.:____________________________

STOP

GRAVITY OR MOTORIZED DAMPER REQUIREMENTS

Division B, Sentence 12.3.4.5.(5) sets out the requirements for dampers to be installed in HVAC system serving a single zone.

Division B, Sentence 12.3.4.5.(5)

> *An exhaust duct with a design capacity of more than 140 L/s on a heating, ventilating and air conditioning system that does not operate continuously shall be equipped with a gravity or motorized damper that will automatically shut when the system is not in operation.*

BALANCING REQUIREMENTS

Division B, Sentence 12.3.4.5.(6) sets out the requirements for balancing an air duct system within an HVAC system serving a single zone. The system is required to be balanced in the following sequence:

Division B, Sentence 12.3.4.5.(6)

1. *Minimize throttling losses.*
2. *If the fan is rated for more than 0.75 kW, adjust the fan speed to meet design flow conditions.*

Additionally, a hydronic system is required to be proportionately balanced to minimize throttling losses, as per Sentence 12.3.4.5.(7).

END

MODULE 10

PART 9 NON-RESIDENTIAL SERVICE WATER HEATING

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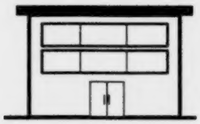
INTRODUCTION



This module describes the minimum performance requirements for service water heating that can be used as an alternative to SB-10 used in combination with ASHRAE 90.1 or the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) for Part 9 non-residential buildings without electric heating for building permit applications submitted up to December 31, 2011.

This module describes design solutions to provide energy efficient service water heating. To limit excessive energy consumption, the Code requires minimum efficiency values, insulation requirements, temperature control, and the installation of heat traps.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Apply the requirements for minimum efficiency for service water heating as found in SB-10
- Calculate the minimum efficiency rating of different types of heating equipment
- Identify requirements for installation of heat traps
- Identify where controls are necessary to automatically shut down heating equipment during extended periods
- Identify maximum temperatures for water delivered to lavatories in public washrooms

READ TO THE NEXT STOP.

APPLICATION OF SB-10

The Energy Efficiency Supplementary Standard SB-10 sets the minimum performance requirements of the service water heating equipment. The minimum performance is expressed by the minimum efficiency value.

As referenced in Sentence 12.3.4.6.(1), SB-10 is used to determine the minimum efficiency value only for the following equipment types for Part 9 non-residential buildings without electric space heating:

- Water heating equipment
- Potable hot water supply boilers
- Hot water storage tanks

CALCULATION OF MINIMUM EFFICIENCY VALUES

The minimum efficiency value is primarily a function of the equipment type and size and is calculated using specific equations listed in SB-10, Table 7.8 "Water Heating Equipment, Performance Requirements".

These equations require input such as the following:

- standby loss (SL) in Watts or Btu/h
- storage capacity (V) in litres or gallons
- thermal efficiency (E_t)
- energy efficiency factor (EF)
- flow rate (Q)

Where multiple equations are provided to determine the minimum performance requirements, the equipment must have an efficiency value that satisfies **all** of the listed requirements.

STOP

EXAMPLE

What is the mathematical expression representing the minimum performance requirement for a gas hot water supply boiler having a storage capacity of 30 Liters?

Solution:

→ Sentence 12.3.4.6.(1) references SB-10 for minimum efficiency values for hot water supply boilers

→ Refer to Table 7.8 "Water Heating Equipment, Performance Requirements"

→ Locate Hot Water Supply Boilers Gas in Column 1

→ Applicable formula to calculate the minimum efficiency for a 300L gas storage water heater is:

- Efficiency = 80% E_t

COMPLETE THE NEXT EXERCISE

EXERCISE 10-1

What is the mathematical expression representing the minimum performance requirement for an oil storage water heater with a heating capacity of 20 kW and having a storage capacity of 100 Liters.

____

____

____

____

____

Code Ref.:________________________________

STOP

HOT WATER HEATING PIPING INSULATION

The insulation of hot water piping contributes to energy conservation by reducing the heat loss from the pipes.

Sentence 12.3.4.6.(2) sets out the minimum insulation requirements for domestic hot water piping in Part 9 non-residential buildings without electric space heating.

Division B, Sentence 12.3.4.6.(2)

> *Domestic hot water heating piping shall be insulated in accordance with Table 12.3.4.5. if it is,*
>
> *(a) recirculating system piping,*
>
> *(b) located within the first 2.5 m of outlet piping in a constant temperature non-recirculating storage system,*
>
> *(c) an inlet pipe located between the storage tank and a heat trap in a non-recirculating storage system, or*
>
> (d) *a pipe that is externally heated by methods such as a heat trace or impedance heating.*

Table 12.3.4.5. "Minimum Thickness of Pipe Insulation" requires that insulation have a thermal conductivity less than 0.42 W/m°C and have a minimum insulation thicknesses of:

- 12 mm for pipe sizes less than or equal to 40 mm
- 25 mm for pipe sizes more than 40 mm

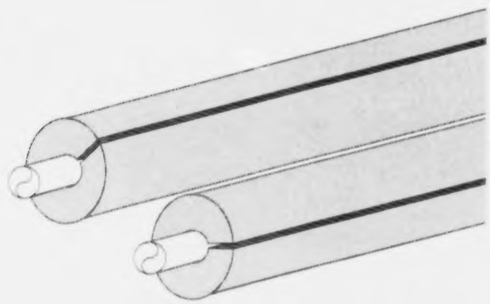


Figure 10- 1 Pipe Insulation

EXAMPLE

A domestic hot water recirculating system has pipes having diameters of 25 mm (1"), 38 mm (1 ½"), and 50 mm (2"). What are the minimum insulation thickness and the maximum thermal conductivity of the insulation material?

Solution:

→ Sentence 12.3.4.5.(3) references Table 12.3.4.5. for minimum thick ness of pipe insulation

→ The thermal conductivity for all insulation material cannot be greater than 0.42 W/mC

→ Pipe diametres of 25 mm and 38 mm require a minimum insulation thickness of 12 mm

→ Pipe sizes with 50 mm require a minimum thickness of 25 mm

COMPLETE THE NEXT EXERCISE

EXERCISE 10-2

A hot water recirculating system has pipes having diameters of 50 mm (2") and 25 mm (1"). What is the minimum insulation thickness for the pipes?

(a) 50 mm and 40 mm, respectively

(b) 40 mm and 25 mm, respectively

(c) 25 mm and 12 mm, respectively

(d) 25 mm and 40 mm, respectively

Code Ref.:

STOP

TEMPERATURE CONTROLS

Maintaining hot water temperatures for an extended period of time uses high amounts of energy. Therefore, Division B, Sentences 12.3.4.6.(3) to (6) limits the amount of energy consumption by mandating temperature controls. Temperature controls are required to be installed for the following:

- Hot water storage tanks: To consist of a temperature control to permit the adjustment of water storage temperature.

- Domestic hot water system designed to maintain usage temperatures in hot water pipes such as for recirculating systems or heat trace: To consist of an automatic time switch or other control to turn off the usage temperature maintenance system when hot water is not required for extended periods.

- Recirculation pumps used to maintain storage tank temperatures: To consist of a control to limit its operation to maximum of 5 minutes from the start of the heating cycle to the end of the heating cycle.

- Lavatories in public facilities: To consist of a device to control the maximum temperature delivered from the lavatory faucet to not more than 43°C.

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 10-3

A gas storage water tank is maintained by a recirculating pump. What is the maximum time the pump can operate after its heating cycle is complete if the building is permitted to be designed under Subsection 12.3.4.?

(a) 10 minutes

(b) 3 minutes

(c) 2 minutes

(d) 5 minutes

Code Ref.:____________________________________

EXERCISE 10-4

A lavatory will be installed in a public change room. What is the maximum water temperature that can be delivered from the lavatory if the building is permitted to be designed under Subsection 12.3.4.?

(a) 40°C

(b) 53°C

(c) 43°C

(d) 50°C

Code Ref.:____________________________________

STOP

HEAT TRAPS FOR VERTICAL PIPE RISERS

Heat traps are loops of pipes or valves that allow water to flow into the water heater tank but prevent unwanted hot-water flow out of the tank. The heat traps have balls inside that reduce standby heat losses.

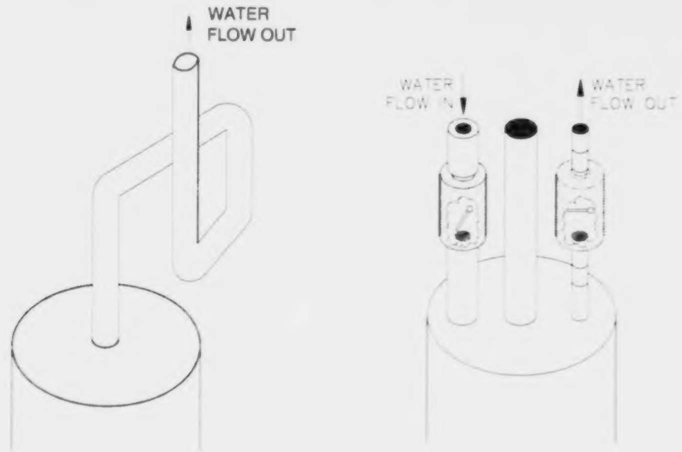


Figure 10- 2 Examples of Heat Trap Installations

Division B, Sentence 12.3.4.6.(7) sets out the minimum requirements for the installation of heat traps in Part 9 non-residential buildings without electric space heating. These requirements may be used as a compliance option up to December 31, 2011.

Division B, Sentence 12.3.4.6.(7)

> *A vertical pipe riser that serves a storage water heater or a storage tank shall have heat traps on both the inlet and outlet piping as close as practical to the tank if,*
>
> *(a) the riser is in a non-recirculating system, and*
>
> *(b) the storage water heater or the storage tank does not have integral heat traps*

END

MODULE 11

PART 9 NON-RESIDENTIAL ELECTRIC MOTORS

RESOURCE CONSERVATION ALL BUILDINGS – 2006

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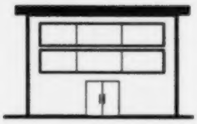

INTRODUCTION

This module describes the provisions for minimum efficiency of electric motors for Part 9 non-residential buildings without space heating.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Apply Sentence 12.3.4.12.(1) to determine the minimum efficiency requirements for electric motors for Part 9 non-residential buildings without electric space heating
- Implement the requirements of SB-10 to determine minimum efficiency of electric motors

READ TO THE NEXT STOP

ELECTRIC MOTORS EFF!CIENCY

An electric motor consumes large amounts of energy.

The amount of energy (input power) required to produce a rated horsepower (output power) varies from motor to motor.

Motor efficiency is the ratio of useful mechanical output power (rated horsepower) to the electrical input power.

Where two motors are rated for the same output horsepower, the efficiency is higher for the motor that requires less input power. The motor that has a higher efficiency has a greater contribution to energy conservation.

APPLICATION OF SB-10 TO ELECTRIC MOTORS

Division B, Sentence 12.3.4.12.(1) references SB-10 to determine the minimum efficiency of electric motors that serve Part 9 non-residential buildings without electric space heating.

Division B, Sentence 12.3.4.12.(1)

> *Electric motors shall conform to the efficiency levels in Supplementary Standard SB-10.*

SB-10 includes Table 10.8 "Minimum Nominal Efficiency for Motors" that sets out the minimum required efficiency for open and closed electrical motors.

An enclosed motor is cooled by means of an internal ventilation system, whereas an open motor is cooled only by an external ventilation system.

The required minimum efficiencies are dependant on the speed (RPM) and the size of the motor (kW or hp).

Manufacturers of electric motors generally provide both of these values.

EXAMPLE

A 3 hp motor running on 60 Hz has a nameplate rating of 1725 RPM at full load, while its calculated speed is 1800 RPM. Determine the minimum efficiency that applies to the open electric motor.

Solution:

→ Refer to Table 10.8 of SB-10

→ The columns in Table 10.8 are divided in two sections: Open Motors and Enclosed Motors

- Under "Open Motors", locate a speed of 1800 RPM (3rd column).

→ The 1st column indicates the power associated to the motor in kW and hp.

- Locate 3 hp

→ The motor must have a minimum efficiency of 86.5%

COMPLETE THE NEXT EXERCISE

EXERCISE 11-1

A 6 pole, 10 hp enclosed motor has a rated efficiency of 87.5%, does the efficiency meet the minimum efficiency set out in SB-10?

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Code Ref.:______________________________

END

MODULE 12

PART 9 NON-RESIDENTIAL LIGHTING

RESOURCE CONSERVATION ALL BUILDINGS – 2006

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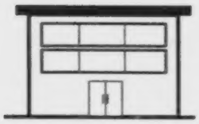

INTRODUCTION

This module describes energy efficient lighting designs requirements for Part 9 non-residential buildings. The lighting requirements set out in Subsection 12.3.4. can be used as an alternative to the requirements of SB-10 used in combination with ASHRAE 90.1, or the 1997 edition of the "Model National Energy Code for Buildings" (MNECB) for Part 9 non-residential buildings.

Energy efficient lighting designs include maximum lighting power allowances and controls.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify when energy conservation provisions apply and do not apply to lighting applications
- Calculate interior lighting power allowance
- Identify equipment and applications exempted from consideration in lighting power allowances
- Calculate exterior lighting power allowance
- Identify lighting controls for interior lighting
- Recognize factors influencing controls of exterior lighting
- Apply minimum ballast efficacy factors set out in SB-10 for fluorescent lighting

READ TO THE NEXT STOP.

APPLICATION OF ENERGY CONSERVATION PROVISIONS FOR LIGHTING

Where the building permit application is submitted up to December 31, 2011, the design of lighting systems for Part 9 non-residential buildings (without electric space heating) is permitted to meet the maximum power allowance set out in Subsection 12.3.4. in lieu of complying with SB-10 and MNECB or ASHRAE 90.1

Sentence 12.3.4.7.(1) sets out the minimum requirements for energy efficient design of lighting for Part 9 non-residential buildings without electric space heating.

Division B, Sentence 12.3.4.7.(1)

Except as provided in Sentence (2), Articles 12.3.4.7. to 12.3.4.11. apply to,

(a) interior spaces of a building,

(b) exterior building features, including facades, illuminated roofs, architectural features, entrances, exits, loading docks and illuminated canopies, and

(c) exterior building ground lighting provided through the building's electrical service.

The application of energy efficient design of lighting systems is required for lighting of interior spaces as well as exterior building features.

Provisions are identified in Sentence 12.3.4.7.(1) are as follows:

- Article 12.3.4.7. provides general requirements for lighting
- Article 12.3.4.8. provides interior lighting requirements
- Article 12.3.4.9. provides interior lighting control requirements

- Article 12.3.4.10. provides exterior lighting requirements
- Article 12.3.4.11. provides exterior lighting control requirements

Sentence 12.3.4.7.(2) specifies that Articles 12.3.4.7. to 12.3.4.11. do not apply to emergency lighting.

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 12-1

Identify whether or not the provisions of Articles 12.3.4.7 to 12.3.4.11 generally apply to the following lighting systems:

Lighting system serving	Apply	Do not apply	Code Ref.
Example: Interior spaces of a 5 storey office building		✓	Clause 12.2.1.1.(4)(a)
Loading dock serving a single storey 500 m^2 warehouse (without electric space heating)			
Emergency lighting in a Part 9 non-residential building			
Exits in an apartment building			

STOP

LIGHTING POWER ALLOWANCE

Where the provisions of Subsection 12.3.4 are used in lieu of complying with SB-10 in combination with MNECB or ASHRAE 90.1. The maximum power allowance is determined based on the building's use and area and their corresponding lighting power density.

Calculations are to be performed for the interior and exterior of buildings.

CALCULATION OF INTERIOR POWER ALLOWANCE

Sentence 12.3.4.8.(1) sets out the provisions for calculating the maximum total interior power allowance.

Division B, Sentence 12.3.4.8.(1)

> *The total interior lighting power allowance for a building is the sum of the lighting power allowances ...*

The determination of the interior lighting power allowance is a function of the use and occupancy of the illuminated area and the corresponding density factor, as identified in Table 12.3.4.8 "Interior Lighting Power Densities".

The sum of all individual power allowances used by luminaries in a building, (including lamps, ballasts, current regulators and control devices) is the maximum total interior power lighting allowance permitted to serve interior lighting. The individual power allowances are found using Table 12.3.4.8. "Interior Lighting Power Densities".

EXCEPTIONS TO INTERIOR POWER ALLOWANCE

Sentence 12.3.4.8.(5) includes areas or features of a Part 9 non-residential building (without electric space heating) that are exempted from the calculation of the interior lighting power allowance. These areas include the following:

- Instrumentation or equipment lighting that is installed by its manufacturer
- Lighting for medical or dental procedures
- Lighting of refrigerator or freezer cases (either open or glass-enclosed)
- Lighting integral to food warming or preparation
- Lighting for plant growth or maintenance
- Lighting designed for visually impaired persons
- Lighting for retail display windows, where enclosed by ceiling height partitions
- Lighting for interior spaces of designated heritage buildings
- Lighting that is integral to advertising or directional signage
- Exit signs
- Display lighting for sale
- Lighting demonstration systems for educational purposes

EXAMPLE

Calculate the maximum interior lighting power allowance for a 500 m^2 warehouse.

Solution:

Locate the appropriate row in Table 12.3.4.8. "Interior Lighting Power Densities" for a warehouse. The interior lighting power density is 9 W/m^2. Multiply this by the gross lighted area of the warehouse.

Interior lighting power allowance

$$= 9\ W/m^2 \times 500\ m^2 = 4500\ W$$

STOP

COMPLETE THE NEXT TWO EXERCISES.

EXERCISE 12-2

Calculate the maximum interior lighting power allowance for a 3 storey building having a building area of 500 m^2. if using the provisions of Subsection 12.3.4. One half of the ground floor is a retail store; the other half is a post office. The top two storeys are office occupancy.

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Code Ref.:________________________________

EXERCISE 12-3

What is the maximum interior lighting power permitted for a medical clinic having a floor area of 500 m^2.

(a) 5,500 W

(b) 5,000 W

(c) 7,000 W

(d) 8,000 W

Code Ref.:______________________________

STOP

CALCULATION OF EXTERIOR POWER ALLOWANCE

The requirements for exterior lighting for Part 9 non-residential buildings are set out in Article 12.3.4.10.

The determination of the exterior lighting power allowance of a Part 9 non-residential is a function of the type of illuminated space or feature (e.g. uncovered parking lots, walkways, drive-up windows, etc.) and their corresponding density factor.

Some of these features have an area attributed to them (e.g. uncovered parking lots), while others have a length attributed to them (e.g. walkways).

The density or linear factor corresponding to exterior areas and features are identified in Table 12.3.4.10. "Exterior Lighting Power Densities".

MAXIMUM TOTAL EXTERIOR LIGHTING POWER ALLOWANCE

Sentence 12.3.4.10.(4). sets out the method to determine the total exterior lighting power allowance for Part 9 non-residential buildings.

Division B, Sentence 12.3.4.10.(4)

> *The total exterior lighting power allowance for the exterior areas appurtenant to a building is the sum of the individual power allowances [...] plus an additional unrestricted allowance of 5% of that sum.*

The total exterior lighting power allowance is the sum of all individual power allowances applicable to a building site, **plus** an additional allowance of 5% added to the total.

This total allowance is the maximum power permitted to serve exterior lighting.

EXCEPTIONS TO EXTERIOR POWER ALLOWANCE

Sentence 12.3.4.10.(2) exempts some exterior areas of a building when calculating the exterior lighting power allowance. These areas include the following:

- Lighting associated with transportation such as specialized signaling, directional or marker lighting
- Advertising or directional signage
- Instrumentation or equipment lighting that is installed by its manufacturer
- Temporary lighting

- Lighting for industrial production, material handling, transportation sites, and associated storage areas
- Feature lighting for illumination of public monuments and heritage buildings

EXAMPLE

Calculate the exterior lighting power allowance for an exterior stairway having an area of 15 m^2.

Solution:

Locate the appropriate row in Table 12.3.4.10. "Exterior Lighting Power Densities" for an exterior stairway. The exterior lighting power density is 10.8 W/m^2.

Exterior lighting power allowance

$$= 15\ m^2 * 10.8\ W/m^2 = 162\ W$$

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 12-4

Calculate the exterior lighting power allowance for a 100 m^2 fast food restaurant having the following features:

- Two drive-up windows
- 600 m^2 parking lot
- two main entrances (single door at each location)
- one service entrance (single door)
- 25 metre long canopy at front of building, 2 metres deep

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____

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Code Ref.:______________________________

EXERCISE 12-5

What is the total (including the unrestricted) exterior lighting power allowance permitted for the fast food restaurant in Exercise 12-4

(a) 2697 W

(b) 2700 W

(c) 2569 W

(d) 2832 W

____

____

Code Ref.:______________________________

STOP

INTERIOR LIGHTING CONTROLS

Automatic control devices to shut off interior lighting are required in all Part 9 non-residential buildings over 500 m^2 in building area, as per Sentence 12.3.4.9.(1). This requirement has been established to limit excessive energy consumption.

The automatic control device for lighting can operate in one of three ways:

Division B, Sentence 12.3.4.9.(3)

(a) Scheduled basis using a time-of-day operated...that turns lighting off at specific programmed times

(b) An occupant sensor that turns lighting off within 30 minutes after occupants have left the space

OR

(c) A signal from any control or alarm system that indicates the area is unoccupied.

Additional features are required to make the control device safe, practical and convenient. Sentences 12.3.4.9.(6) and (7) sets out the minimum requirements for individual control devices, they must:

- Be readily accessible to occupants if manually operated.
- Activate either manually or automatically by sensing an occupant.
- Control a floor area of not more than 240 m^2

AND

- Be capable of overriding at anytime, for not more than 4 hours.

Sentence 12.3.4.9.(8) provides specific requirements for the following areas. Lighting control devices serving these areas are required to automatically turns lighting off within 30 minutes of all occupants leaving the space:

- Conference rooms
- Meeting rooms
- Employee lunch/break rooms

Sentence 12.3.4.9.(9) requires separate lighting control devices for display lighting, accent lighting, case lighting, task lighting, non-visual lighting, and demonstrating lighting.

As per Sentence 12.3.4.9.(2), automatic lighting controls are not permitted to control.

Division B, Sentence 12.3.4.9.(2)

(a) Lighting intended for 24-hour operation

(b) emergency lighting,

(c) 24 hour lighting

(d) lighting for spaces where an automatic shut-off would endanger safety or security.

COMPLETE THE NEXT EXERCISE

EXERCISE 12-6

Identify whether the following statements are true or false?

(a) A single control device can serve a floor area of 500 m^2

____

Code Ref.: ______________________________

(b) A control device that automatically turns lighting off within 30 minutes is required in office space.

____

Code Ref.: ______________________________

STOP

EXTERIOR LIGHTING CONTROLS

Similar to interior lighting, exterior lighting is required to have automatic controls so that it is off when not required.

Sentence 12.3.4.11(1) requires automatic controls to turn off exterior lighting to limit energy consumption.

Division B, Sentence 12.3.4.11(1)

Except as provided in Sentence (2), lighting for exterior applications shall have automatic controls capable of turning off exterior lighting when,

(a) sufficient daylight is available, or

(b) the lighting is not required during night time hours.

Sentence 12.3.4.11(2) exempts these requirements for:

- lighting at exits,
- covered vehicle entrances,
- parking structures,

and

- where lighting is required for safety, security, or eye adaptation.

Automatic controls shall consist of a time switch, or a photosensor where design for dusk-dawn operation.

COMPLETE THE NEXT EXERCISE

EXERCISE 12-7

Control devices capable of turning off exterior lighting for dusk-to-dawn operations in an open-air parking structure are required to be controlled by:

(a) time switch

(b) photosensor

(c) time switch or photosensor

(d) no control devices

____

____

Code Ref.:________________________________

STOP

FLUORESCENT LIGHTING

Where fluorescent lighting is provided in a Part 9 non-residential building, the fluorescent ballasts are required to comply with the minimum ballast efficacy factor set out in SB-10, as referenced by Sentence 12.3.4.7.(3).

The ballast efficacy factor (BEF) is calculated as follows:

$$BEF = \frac{\text{Ballast Power Factor [\%]}}{\text{Power Input [Watt]}} \qquad \text{(Eq 9-1, SB-10)}$$

Table 9.1.5.1. "Fluorescent Lamp Ballast Efficacy Factors" in SB-10 contains minimum BEF values for different fluorescent lighting fixtures. These values are the minimum ballast efficacy factors for fluorescent lighting having all of the following characteristics:

- Input voltage: 120, 277, or 347V
- Input frequency: 60 Hz
- Maximum current: 1A
- Operated above 4.5°C
- Not operated with dimming controls
- Specific lamp types (as described in SB-10)

Lamps that do not meet these characteristics do not need to meet BEF vales in Table 9.1.5.1 of SB-10

COMPLETE THE NEXT EXERCISE

EXERCISE 12-8

What is the minimum ballast efficacy factor for two F32T8 Lamps having a ballast input voltage of 120V?

(a) 1.25

(b) 1.23

(c) 1.2

(d) Cannot be determined, the ballast factor is not provided.

Code Ref.:

STOP

TANDEM-WIRING

Tandem wiring is a technique where a pair of lighting fixtures share common ballasts. Tandem-wiring allows for fewer ballasts in the combination, thus reducing material costs, energy, and field labor

Two-lamp tandem–wiring is required where luminaries are used with one or three fixtures greater than 30W each in a Part 9 non-residential.

Figure 12- 1 Fixture without two-lamp tandem-wiring

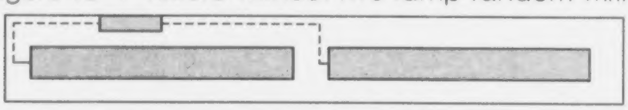

Figure 12- 2 Fixture with two-lamp tandem-wiring

However, Sentence 12.3.4.7.(3) exempts this requirement for the following:

- Recessed luminaires separated by 3 metres (centre to centre)
- Non continuous surface or pendant luminaries
- Luminaries with single-lamp or three-lamp high frequency electronic ballasts
- Luminaries with three-lamp electromagnetic ballasts
- Luminaires on emergency power

END

MODULE 13

ALL BUILDINGS
MOTION SENSORS

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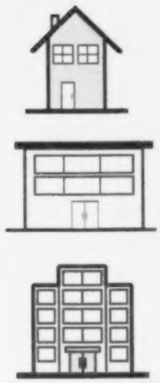

INTRODUCTION

This module focuses on how motion sensors can contribute to an energy efficient design for all buildings. The limitations on their use are also described.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify limitations for use of motion sensors to control lighting
- Recognize the features for controls of motion sensors

READ TO THE NEXT STOP

APPLICATION

As per Article 12.2.2.1. motion sensors are permitted to be used to control lighting in all buildings, with certain limitations (addressed below).

LIMITATIONS

Although motion sensors contribute to energy conservation, motion sensors **are not permitted** to control lighting installed in the following areas:

- Exits
- Corridors serving patients or residents in Group B, Division 2 or Division 3 occupancies
- Floor level illumination in places of assembly intended for the viewing of motion pictures or the performing arts

Motion sensors are permitted in these areas, if the motion sensors control **supplementary** lighting that is provided over and above the minimum lighting levels set out in Article 3.2.7.1. (minimum lighting requirements), Article 9.9.11.2. (egress facilities), and Article 9.34.2.7.(public and service areas).

In addition to the three areas noted above, motion sensors are **not permitted to control emergency lighting**, as per Sentence 12.2.2.1.(3). Requirements for emergency lighting are described elsewhere in the Code, including Division B, Article 3.2.7.3. and 9.9.11.3.

STOP

CONTROLS

Additional features are required for motion sensors installed in specific locations, as set out in Sentence 12.2.2.1.(2).

Division B, Sentence 12.2.2.1.(2)

> *Where motion sensors are used to control minimum lighting in a public corridor or corridor providing access to exit for the public…*

In these locations, the motion sensor must have the following additional features, as per Sentence 12.2.2.1.(2):

- Switch controllers equipped for fail-safe operation that will override the motion sensor in the event that the sensor malfunction does not detect movement.

AND

- Illumination timers must be set to stay on for a minimum of 15 minutes duration.

These features apply only to public corridors or a corridor providing access to exit for the public.

Division A, Article 1.4.1.2. defines a **public corridor** as "*...a corridor that provides access to exit from more than one suite*".

Therefore, all corridors providing access to exit for the public or corridors, which serve more than one suite, are required to meet Sentence 12.2.2.1.(2).

As described by Functional Statements F10 and F30 which are attributed to these provisions as per Table 12 of SA-1, these control features will provide minimum illumination levels to facilitate the movement of occupants and to reduce the risk of injuries as a result of tripping, slipping, etc.

EXAMPLE

A new 10 storey office building is designed to have two meeting rooms on each floor. One of the meeting rooms is designed for an occupant load of 50 persons, and the other meeting room for an occupant load of 75 people.

Are the minimum illumination levels for each of these rooms permitted to be controlled with motions sensors?

Solution:

→ Sentence 12.2.2.1.(1) generally permits the use of motion sensors in these areas.

→ Emergency lighting is not permitted to be controlled by motion sensors.

→ Emergency lighting is required in an assembly area having an occupant load greater then 60 people, as per Division B, Subclause 3.2.7.3.(1)(h)(ii).

Therefore:

→ Meeting room designed for 50 persons: Motion sensors are permitted to control lighting in the meeting room serving 50 persons. Emergency lighting is not required in this room as per Division B, Subclause 3.2.7.3.(1)(h)(ii)

→ Meeting room designed for 75 persons: Motion sensors are permitted to control normal lighting, but are not permitted to control the required emergency lighting that is required by Division B, Subclause 3.2.7.3.(1)(h)(ii) in meeting room having an occupant load of more than 60 persons

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 13-1

For each of the areas listed below identify whether motion sensors are permitted or not permitted to control minimum illumination levels (unless indicated otherwise).

Area	Permitted	Not Permitted	Code Ref.
Example: Public corridor serving the pediatric unit of a hospital		✓	Clause 12.2.2.1(1)(b)
Classrooms in an elementary school			
Lighting at floor levels in a movie theatre			
Public corridor of a hotel			
Supplementary lighting (additional to 50 lx) in a corridor serving a nursing home			
Service hallways			
Stairwell serving an apartment building			

END

MODULE 14

ALL BUILDINGS
WATER EFFICIENCY

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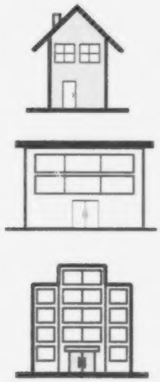

INTRODUCTION

This module focuses on how maximum flow rates of water supply fittings and flush cycles for plumbing fixtures contribute to water conservation in all buildings.

OBJECTIVES

Upon completion of this module, participants will be able to:

- Apply the requirements of Subsection 7.6.4., as cross-referenced in Part 12
- Identify the maximum flow rates for water fixtures
- Identify the maximum flush cycles for new sanitary plumbing fixtures
- Identify the maximum flush cycles for sanitary fixtures that replace existing fixtures

READ TO THE NEXT STOP

APPLICATION OF WATER EFFICIENCY

Sentence 12.4.1.1(1) references Subsection 7.6.4. for water efficiency and the requirements for new water supply fittings and plumbing fixtures in all buildings.

Division B, Sentence 12.4.1.1.(1)

> *All buildings shall conform to the water efficiency requirements of Subsection 7.6.4.*

The water efficiency requirements in Subsection 7.6.4 support the objective OR1 "Resource Conservation – Water Conservation". Water efficiency requirements apply to water supply fittings and plumbing fixtures.

Where new fixtures are being installed as a result of **renovations**, separate requirements in Subsection 7.6.4. apply to these sanitary fixtures that will be installed as a replacement of existing fixtures in a building that was constructed prior to January 1996. The provisions set out in Subsection 7.6.4. apply as referenced by Part 11 "Renovation".

MAXIMUM FLOW RATES FOR WATER SUPPLY FITTINGS

Table 7.6.4.1. "Maximum Flow Rates for Water Supply Fittings" sets out the maximum flow rates (Litres/minute) at specific test pressures (kPa) for the following fixtures in buildings:

Lavatory faucets

Kitchen faucets

Shower heads

The flow rating of fixtures at specific test pressures are typically provided by the manufacturer.

The flow rating of **each fixture** must be less than or equal to the flow rates set out in Table 7.6.4.1. "Maximum Flow Rates for Water Supply Fittings".

However, where a single person shower stall or facility is provided with **more than one** shower head, the combined flow rate of all fixtures in that shower stall or facility must meet the maximum flow rates set out in Table 7.6.4.1.

EXAMPLE

What is the maximum flow rate for a faucet installed in a public washroom?

Solution:

→ Refer to Table 7.6.4.1. "Maximum flow rates for Water Supply Fixtures"

- Lavatory faucet: less than 8.35 L/min (tested at 413 kPa)

STOP

COMPLETE THE NEXT EXERCISE

EXERCISE 14-1

Showers will be installed in a new recreational facility. A single shower head will be provided for each shower stall. The new shower heads were each tested at 550 kPa for 5 minutes. The total flow out of each fitting was 45 Litres. Is this shower head permitted to be installed in the new facility?

(a) Yes. Flow rate is less than the maximum permitted flow rate

(b) No. Flow rate cannot be determined

(c) No. Flow rate is greater than the maximum permitted flow rate

(d) No. Flow was tested at a different pressure

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Code Ref.: ________________________________

STOP

MAXIMUM FLUSH CYCLES FOR SANITARY FIXTURES

As per Division B, Sentence 7.6.4.2.(1), new water closets and urinals in all buildings (subject to exception for replacement fixtures – see below) are required to be:

> *...certified to CAN/CSA-B45.0 'General Requirements for Plumbing Fixtures'*

In addition to the requirements of CAN/CSA-B45.0, Table 7.6.4.2.B "Maximum Flush Cycles for Sanitary Fixtures" lists the maximum flush cycles for the following sanitary fixtures:

- Water closet (tank type)
- Water closet (direct flush)
- Urinal (tank type)
- Urinal (direct flush)

A flush cycle is a volume of water [Litres] used to complete one full flush for sanitary fixtures (urinals and water closets).

MAXIMUM FLUSH CYCLES FOR SANITARY FIXTURES THAT REPLACE EXISTING FIXTURES

Flush cycles for **replacement** sanitary fixtures are permitted to be higher than flush cycles for sanitary fixtures installed in new buildings.

Table 7.6.4.2.A. "Maximum Flush Cycles for Sanitary Fixtures" sets out the maximum flush cycles for water closets and urinals installed to replace existing fixtures in a building that was constructed prior to January 1, 1996.

If the new sanitary fixture replaces another *fixture* that was installed after January 1, 1996 in a building constructed before January 1, 1996, the higher flush cycle is still permitted.

EXAMPLE

How much water is permitted to be used for a flush cycle for a new toilet (without a tank) installed in a new shopping centre?

Solution:

→ The building is new, therefore Table 7.6.4.2.B. "Maximum Flush Cycles for Sanitary Fixtures" is applicable

→ The toilet is a tank type

→ The maximum flush cycle is 6 Litres

STOP

COMPLETE THE NEXT TWO EXERCISES

EXERCISE 14-2

What is the maximum flush cycle for a urinal equipped with automatic controls that will be installed in a new office building? What additional provisions must be taken for automatic flushing devices?

(a) 5.68 Litres

(b) 3.8 Litres

(c) 6 Litres

(d) 13.25 Litres

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Code Ref.: ______________________________

EXERCISE 14-3

What is the maximum flush cycle for a water closet that will be replacing an existing toilet that was installed in 1998 in a building that was constructed in 1985?

(a) 5.68 Litres

(b) 3.8 Litres

(c) 6 Litres

(d) 13.25 Litres

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Code Ref.: ______________________________

STOP

EXCEPTIONS TO WATER EFFICIENCY REQUIREMENTS

New faucets, shower heads, water closets, and urinals installed in ***heritage buildings*** do **not** need to meet the requirements for maximum flow rates [Table 7.6.4.1.] nor the maximum flush cycles [Tables 7.6.4.2.A and 7.6.4.2.B].

Division A, Article 1.4.1.2. defines a heritage building as a building that is:

(a) ...designated under the Ontario Heritage Act,

OR

(b) ... certified to be of significant architectural or historical value by a recognized, non-profit public organization whose primary object is the preservation of structures of architectural or historical significance and the certification has been accepted by the chief building official."

Also, new water closets and urinals installed in the following buildings **do not need to meet the maximum flush cycles** [Table 7.6.4.2.A and Table 7.6.4.2.B]:

- Passenger Stations (e.g. bus stations, train station, subway, etc.)
- Care or detention occupancies

Division A, Article 1.4.1.2. defines a care or detention occupancy as follows:

> *Care or detention occupancy: means the occupancy or use of a building or part of a building by persons who,*
>
> *(a) are dependent on others to release security devices to permit egress*
>
> *(b) receive special care and treatment; or*
>
> *(c) receive supervisory care.*

However, the maximum flow rates established by Table 7.6.4.1. "Maximum Flow Rates for Water Supply Fittings" are applicable to the above locations.

SUMMARY OF REQUIREMENTS

The following table summarizes the maximum flow rates for water supply fittings as well as the maximum flush cycles for sanitary fixtures.

Fixture	Maximum Flow Rates (L/min) and Flush Cycle (L) (In buildings existing before January 1, 1996)	Maximum Flow Rates (L/min) and Flush Cycle (L) (In new buildings as well as in buildings existing after January 1, 1996)
Lavatory Faucets	8.35 L/min	
Kitchen Faucets	8.35 L/min	
Shower Heads	9.5 L/min	
Water Closets	13.25 L	6 L
Urinals	5.68 L	3.8 L

END

ANSWER GUIDE

RESOURCE CONSERVATION ALL BUILDINGS – 2006

<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td colspan="2">Module 1 Application of Part 12 Resource Conservation</td></tr>
<tr><td>Exercise 1-1</td><td>Possible answers include:
Designated structures
Tents
Decks
Etc.</td></tr>
<tr><td>Exercise 1-2</td><td>Refer to Supplementary Standard SA-1, Table 12 and Division A, Table 3.2.1.1.

<table>
<tr><th>Functional Statement and Objective</th><th>Code Provision</th></tr>
<tr><td>Motion Sensors
12.2.2.1.(2)</td><td>F30-OS3.1
and F10-OS3.7</td></tr>
<tr><td>Air Infiltration
12.3.3.13.(2)</td><td>F54-OH1.2
F55-OH1.2
F131-OR2</td></tr>
<tr><td>Thermal Resistance
12.3.3.3.(1)</td><td>F131-OR2</td></tr>
<tr><td>Required Insulation
12.3.2.1.(2)</td><td>F51-OH1.1
F51-OH1.2
F63-OH1.1
F63-OH1.2
F131-OR2
F63-OS2.3</td></tr>
</table></td></tr>
<tr><td>Exercise 1-3</td><td>Yes.

A Part 9 townhouse residential can meet the provisions of Subsection 12.3.3. up to December 31, 2011
Code Ref.: Sentence 12.2.1.1. (1)</td></tr>
<tr><td>Exercise 1-4</td><td>3 options:
ANSI/ASHRAE/IESNA 90.1 and SB-10
MNECB and SB-10
Provisions under Subsection 12.3.4.
Code Ref.: Sentence 12.2.1.1. (2) and (4)</td></tr>
<tr><td>Exercise 1-5</td><td>2 options:
ANSI/ASHRAE/IESNA 90.1 and SB-10
MNECB and SB-10
Code Ref.: Sentence 12.2.1.1.(2)</td></tr>
<tr><td>Exercise 1-6</td><td>The design must exceed the energy efficiency levels of the MNECB by at least 25%.</td></tr>
</table>

Exercise Number	Answer
	Code Ref.: Sentence 12.2.1.2.(3)
Exercise 1-7	(d) All part 3 buildings are required to meet ANSI/ASHRAE/IESNA 90.1 and SB-10 **or** MNECB and SB-10, Code Ref.: Sentence 12.2.1.1.(2).
Exercise 1-8	

	(a)				(b)
Design Requirements.	**Part 9 Res.**	**Part 9 Non-Res**	**All other Buildings**	**N/A**	**Code Ref.**
MNECB+25%:				✓	Article 12.2.1.2.
Thermal Resistance of Building Envelope:		✓			Sentence 12.2.1.1.(4)
80 rating:	✓				Clause 12.2.1.1.(3)(c)
ANSI/ASHRAE/IESNA 90.1 and SB-10:		✓	✓		Sentence 12.2.1.1.(4) and (2), respectively

Exercise Number	Answer
Exercise 1-9	

	(a)				(b)
Design Requirements.	**Part 9 Res.**	**Part 9 Non-Res**	**All other Buildings**	**N/A**	**Code Ref.**
Thermal Insulation:				✓	Article 12.2.1.2.
MNECB+25%:		✓	✓		Sentence 12.2.1.2.(2)
Thermal Resistance of Building Envelope:				✓	Clause 12.2.1.2.
80 rating:	✓				Sentence 12.2.1.2.(3)
ANSI/ASHRAE/IESNA 90.1 and SB-10:				✓	Article 12.2.1.2.

<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td colspan="2">Module 2 Part 9 Residential – Thermal Insulation Compliance Option</td></tr>
<tr><td>Exercise 2-1</td><td>(b) 4400

Code Ref.: Table 1.2 “Design Data for Selected Locations in Ontario” in Supplementary Standard SB1. Column 6 lists the number of degree-days below 18°C</td></tr>
<tr><td>Exercise 2-2</td><td>
<table>
<tr><th>Location</th><th>HDD</th><th>HDD Zone</th></tr>
<tr><td>Belleville</td><td>4100</td><td>1</td></tr>
<tr><td>Ajax</td><td>4000</td><td>1</td></tr>
<tr><td>Timmins</td><td>6200</td><td>2</td></tr>
<tr><td>Dryden</td><td>6000</td><td>2</td></tr>
<tr><td>Thunder Bay</td><td>5650</td><td>2</td></tr>
<tr><td>Aurora</td><td>4300</td><td>1</td></tr>
</table>

Code Ref.: SB-1, Table 1.2 Design Data for Selected Locations in Ontario.</td></tr>
<tr><td>Exercise 2-3</td><td>Sault Ste. Marie has 5100 heating degree-days and is in Zone 2.

Exterior walls: 5.10 $m^2{}^{\circ}C/W$
Foundation walls: 3.34 $m^2{}^{\circ}C/W$
Interior Walls: N/A
Ceiling below attic: 8.8 $m^2{}^{\circ}C/W$

Code Ref.: Sentence 12.3.2.1.(1) and (4) and Table 12.3.2.1.</td></tr>
<tr><td>Exercise 2-4</td><td>Ajax in located in Zone 1.
<table>
<tr><th>Assembly</th><th>Min RSI</th></tr>
<tr><td>Concrete Basement floor located at 500 mm below grade</td><td>1.41</td></tr>
<tr><td>Ceiling below attic space:</td><td>7</td></tr>
<tr><td>Exterior Wall:</td><td>3.34</td></tr>
<tr><td>Ground floor:</td><td>N/A</td></tr>
</table>

Code Ref.: Sentence 12.3.2.1.(4) and Table 12.3.2.1.</td></tr>
</table>

<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td>Exercise 2-5</td><td>
Ajax in located in Zone 1.
<table>
<tr><th>Assembly</th><th>Min RSI</th></tr>
<tr><td>Concrete Basement floor located at 500 mm below grade</td><td>1.41</td></tr>
<tr><td>Ceiling below attic space:</td><td>8.4</td></tr>
<tr><td>Exterior Wall:</td><td>4</td></tr>
<tr><td>Ground floor:</td><td>N/A</td></tr>
</table>

Code Ref.: Sentence 12.3.2.2.(2) and Table 12.3.2.1.
</td></tr>
<tr><td>Exercise 2-6</td><td>
Thermal performance can be evaluated based on the maximum coefficient of heat transfer and the minimum energy rating.

(a) Sliding doors:

Max. coeff. of heat transfer: 2.0 W/ $m^2 \cdot °C$
Min Energy rating: 17

Code Ref.: Sentence 12.3.2.7.(2)

(b) Fixed windows:

Max. coeff. of heat transfer: 2.0 W/ $m^2 \cdot °C$
Min Energy rating: 27

Code Ref.: Sentence 12.3.2.6.(1)and Subclause 12.3.2.6.(1)(b)(ii)

(c) Operable windows:

Max. coeff. of heat transfer: 2.0 W/ $m^2 \cdot °C$
Min Energy rating: 17

Code Ref.: Sentence 12.3.2.6.(1) and Subclause 12.3.2.6.(1)(b)(i)
</td></tr>
</table>

Exercise Number	Answer
Exercise 2-7	(b) 5.23 m^2°C/W Kenora = Zone 2 The RSI value for the total wall assembly for log houses can be reduced from 2.1 m^2°C/W to as low as 1.61 m^2°C/W. If the wall assembly has an RSI value of 1.8. Reduction = Required RSI value– Proposed RSI value Reduction = 2.1 - 1.8 Reduction = 0.3 m^2°C/W in the wall assembly Therefore, the insulation values in Table 12.3.2.1. for exposed roofs must be increased by 0.3. Required RSI for insulation = 4.93 + 0.3 = 5.23 m^2°C/W Code Ref.: Sentence 12.3.2.9.(2)
Exercise 2-8	(a) 1.76 m^2°C/W The root RSI requirements are set out in Table 12.3.2.1. "Minimum Thermal Resistance of Insulation to be Installed Based on Degree-Day Zones" The house will have a gas-fire forced air heating system. (Columns 2 and 3 are applicable) The slab-on-ground contains heating pipes (Row 7 is applicable) The RSI values listed in Columns 2 and 3 that are associated to Row 7 are the same. Therefore, the degree-days do not need to be computed. A minimum RSI of 1.76 m^2°C/W is applicable. Sentence 12.3.2.4.(7) is not applicable (slab-on-ground is not insulated on the entire underside). Code Ref.: Table 12.3.2.1. and Sentence 12.3.2.4.(7)
Exercise 2-9	Building is a Part 9 residential building. Minimum annual fuel utilization efficiency for propane furnace is 90%

Exercise Number	Answer
Module 3 Part 9 Residential – Thermal Insulation Compliance Option	
Exercise 3-1	Wall assembly: 3.8 m^2°C/W Floor assembly: N/A The minimum RSI values for the wall assemblies are applicable only to building elements exposed to unheated areas. The building does not have electric heating: HDD = 4350. Code Ref.: Table 12.3.3.3.
Exercise 3-2	(a) 2.1 m^2°C/W Code Ref.: Sentence 12.3.3.8.(1) (b) 5.21 m^2°C/W Code Ref.: Sentence 12.3.3.8.(1) and Table 12.3.3.3.
Exercise 3-3	(a) at least 600 mm below adjacent ground level. Code Ref.: Sentence 12.3.3.9.(2)
Exercise 3-4	(b) 21.6 m^2 Maximum permitted glazing is limited by both 20% of floor area and 40% of wall area. Floor area = width x depth Floor area = 6 x 18=108 m^2 20% of floor area = 0.2 x 108 = 21.6 m^2 Wall area= 2(depth x height)+2(width x height) Wall area= 2(18 x 3)+2(6 x 3)= 144 m^2 40% of wall area = 0.4 x 144 =57.6 m^2 Max permitted glazing is limited by 20% of floor area = 21.6 m^2 Code Ref.: Sentence 12.3.3.11.(2)
Exercise 3-5	Yes the proposed glazing does meet the conditions of Sentence 12.3.3.11.(2). Proposed total area of glazing is =total length of windows x height =(2+1+2+1+2+2) x 1m = 10 m^2. Maximum permitted is limited by 20% of floor area = 0.2(60) = 12 m^2. Therefore the proposed glazing are meets the conditions of Sentence 12.3.3.11.(2)

Exercise Number	Answer
Exercise 3-6	(b) 36 Area(effective)=Glazing Factor x Area(actual) 90 m^2=Glazing Factorx120 m^2 Glazing Factor=0.75 Glazing Factor = [Energy Rating (req)]/[Energy Rating (act)] Energy Rating (act) = Energy Rating (req)/(Glazing Factor) Energy Rating(req) = 27/0.75 Energy Rating (required) = 36 Code Ref.: Sentence 12.3.3.11.(3)
Exercise 3-7	(d) Either design (b) or (c) Code Ref.: Sentences 12.3.3.11.(4) and (5)
Exercise 3-8	Yes it is permitted. First, determine if the glazing area satisfies Sentence 12.3.3.11.(2). Floor area =width x depth =10 x 20 = 200 m^2 20% of floor area = 200 m^2 x 0.2 = 40 m^2 Under Sentence 12.3.3.11.(2), the proposed glazing area (50 m^2) is not permitted. However, under Sentence 12.3.3.11.(4): Considered area = 0.5 x 50 m^2 = 25 m^2 Therefore, the proposed glazing area is permitted on the south wall of the new house. Code Ref.: Sentence 12.3.3.11.(2) and (4)
Exercise 3-9	50% of the area should be considered for each window facing south. The considered area of each window is 1 m^2. And the total permitted glazing area is 2 m^2. Code Ref.: Sentence 12.3.3.11.(4)
Exercise 3-10	The windows need to be shaded in the summer with exterior devices. Code Ref.: Sentence 12.3.3.11.(5)
Exercise 3-11	Sliding doors have a maximum overall coefficient of heat transfer of 1.6 W/m^2°C. Code Ref.: Sentence 12.3.2.8.(1)

<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td>Exercise 3-12</td><td>Minimum energy rating for operable windows in an exterior wall is 25.

Code Ref.: Sentence 12.3.2.8.(2)</td></tr>
<tr><td>Exercise 3-13</td><td>Sash crack
= perimeter of all operable portions of a window.
=(1.5 + 0.5) x 2 = 4.0 m

Air leakage rate
= (3.0 Ls)/(4.0 m)=0.75 L/s per meter of sash crack

Maximum air leakage =0.775 L/s per meter of sash crack
0.75 L/s < 0.775 L/s

The proposed window meets the requirement of 12.3.3.13.</td></tr>
<tr><td>Exercise 3-14</td><td>Sliding glass door: 2.5 L/s per m^2 of door area
Code Ref.: Sentence 12.3.3.13.(2)

Operable window: 0.755L/s per metre of sash crack
Code Ref.: Sentence 12.3.3.13.(1)

Entrance door: 17 L/s per metre of sash crack.
Code Ref.: Sentence 12.3.3.13.(4)

Weather stripped and protected by garage: N/A
Code Ref.: Sentence 12.3.3.12.(3)

Junction: N/A
Code Ref.: Sentence 12.3.3.13.(6)</td></tr>
<tr><td colspan="2">Module 4 Part 9 Residential – NRCan EnerGuide Compliance Option</td></tr>
<tr><td>Exercise 4-1</td><td>Yes.

Applications for building permits submitted up to December 31, may achieve a performance level equal to a rating of 80 if evaluated with EnerGuide to meet the minimum energy efficient design requirements of the Code.

Note: The building is not required to meet the minimum thermal design nor insulation requirements of Subsection 12.3.3. or 12.3.4.

Code Ref.: Clause 12.2.1.1.(3)(c)</td></tr>
</table>

Exercise Number	Answer
Module 5 Energy Efficiency for All Buildings other than Part 9 Residential Buildings	
Exercise 5-1	(c) Exceed the provisions set out in MNECB by 25% Code Ref.: Sentence 12.2.1.2.(2)
Exercise 5-2	(d) Any of the above Code Ref.: Sentence 12.2.1.2.(2) and (4)
Exercise 5-3	No. Subsection 12.3.4. is applicable only to Part 9 non-residential buildings that do not have electric space heating. Code Ref.: Sentence 12.2.1.1.(4)
Exercise 5-4	ANSI/ASHRAE/IESNA 90.1 and SB-10 Or MNECB and SB-10 Code Ref.: Sentence 12.2.1.1.(2)
Module 6 Part 9 Non-Residential Thermal Resistance	
Exercise 6-1	(d) 2.82 $m^{2o}C/W$ Sturgeon Falls is Zone 2 Foundation walls extending up to 1200 mm above the finish ground may have an RSI of a below grade wall. Where the min. RSI values apply to insulation only. Code Ref.: Sentence 12.3.4.2.(2) and Table 12.3.4.2.A.
Exercise 6-2	(d) 1.17 $m^{2o}C/W$. The RSI values in 12.3.4.2.B correspond to minimum lengths of 600 mm and 1200 mm. Where the insulation length is different from 600 or 1200 mm, the RSI value may be interpolated to determine the minimum RSI value. The minimum RSI value for the insulation Linear interpolation: $(1200 - 600)(0.7 - RSI_{min})=(1200-800)(0.7-1.41)$ $RSI_{min} = 1.17\ m^{2o}C/W$ Code Ref.: Sentence 12.3.4.2.(3) and Table 12.3.4.2.B.
Exercise 6-3	(c) 1.41 $m^{2o}C/W$ Code Ref.: Sentence 12.3.4.2.(3) and Table 12.3.4.2.B.

Exercise Number	Answer
Module 7 Part 9 Non-Residential – Window Performance	
Exercise 7-1	(b) 0.27 Glazing area = 2(width x height1) = 2(2m x 1m) = 4.0 m^2 Wall area = width x height = 5 m x 3 m= 15 m^2 Window-to-wall area = (4 m^2)/(15 m^2) = 0.27
Exercise 7-2	(b) 2.28 W/m^2℃ Window area = (width of back wall x height of back wall) + 2 (4 m^2) = (10m x 3m) + 2 (4 m^2)= 38 m^2 Wall area = (width of walls x height of walls)4 = (10 m x 3 m)4=120 m^2 Window-to-wall ratio=38 m^2/120 m^2 = 0.32 Base on Table 12.3.4.2.C. The coeff of heat transfer = 2.28 W/m^2℃ Code Ref.: Sentence 12.3.4.2.(4) and Table 12.3.4.2.C
Module 8 Part 9 Non-residential – Air Infiltration	
Exercise 8-1	(d) All of the above Roof assembly: Separates interior from exterior. Wall assemblies: The bank and a public pool are environmentally dissimilar. Slab-on-ground: Separates interior from ground. Code Ref.: Sentence 12.3.4.3.(1)
Exercise 8-2	(d) All of the above
Module 9 Part 9 Non-Residential – HVAC	
Exercise 9-1	(b) 78% SEUE SB-10 requirements are applicable to HVAC systems serving more than a single zone. Code Ref.: Sentence 12.3.4.4.(3) and Table 6.8.1E in SB-10

<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td>Exercise 9-2</td><td>
<table>
<tr><th>System</th><th>Yes</th><th>No</th><th>Code Ref.</th></tr>
<tr><td>HVAC system serving two zones, where the outdoor air supplied is:
- 1500 L/s, and
- 80% of the supply air of the system</td><td></td><td>✓
Sentence 12.3.4.4.(6)

applies to HVAC systems serving a single zone</td><td>Sentence 12.3.4.4.(2)</td></tr>
<tr><td>HVAC system serving a single zones, where the outdoor air supplied is:
- 1000L/s, and
- 80% of the supply air of the system</td><td></td><td>✓
Sentence 12.3.4.4.(6), outdoor air is less than 1400 L/s</td><td>Sentence 12.3.4.4.(3)
Clause 12.3.4.4.(6)(a)</td></tr>
<tr><td>HVAC system serving a single zones, where the outdoor air supplied is:
- 1500 L/s, and
- 80% of the supply air of the system</td><td>✓
Both conditions of 12.3.4.4.(6) are satisfied.</td><td></td><td>Sentence 12.3.4.4.(3) and Clauses 12.3.4.4.(6)(a) and (b)</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td>Exercise 9-3</td><td>
<table>
<tr><th>Feature</th><th>Complies</th><th>Does not Comply</th><th>Code Ref.</th></tr>
<tr><td>Capable of programming for 7 day types/week</td><td>✓</td><td></td><td>Clause 12.3.4.4.(9)(a)</td></tr>
<tr><td>Set a minimum temperature of 10℃ during off hours.</td><td>✓</td><td></td><td>Clause 12.3.4.4.(9)(d)</td></tr>
<tr><td>Manual override that allows for temporary operation for up to 5 hours.</td><td></td><td>✓</td><td>Clause 12.3.4.4.(9)(c)</td></tr>
<tr><td>Retains all settings for a period of 5 hours during loss of power.</td><td></td><td>✓</td><td>Clause 12.3.4.4.(9)(b)</td></tr>
</table>
</td></tr>
<tr><td>Exercise 9-4</td><td>
<table>
<tr><th>Pipe Size and Use</th><th>Min. Thickness of Insulation (mm)</th></tr>
<tr><td>2” pipe serving hot water heating</td><td>40</td></tr>
<tr><td>64 mm pipe serving domestic hot water system</td><td>25</td></tr>
<tr><td>50 mm pipe serving cooling system</td><td>25</td></tr>
<tr><td>1” pipe for steam</td><td>40</td></tr>
</table>
Code Ref.: Sentence 12.3.4.5.(3) and Table 12.3.4.5.
</td></tr>
<tr><td colspan="2">Module 10 Part 9 Non-Residential - Service Water Heating</td></tr>
<tr><td>Exercise 10-1</td><td>Expression for Minimum Efficiency
=0.59-0.0005(V) x EF

Code Ref.: Sentence 12.3.4.6.(1) and Table 7.8 in SB-10</td></tr>
<tr><td>Exercise 10-2</td><td>(b) 40 and 25 mm
- Pipes of 50 mm require 40 mm thick
- Pipes of 25 mm require 25 mm thick

Code Ref.: Sentence 12.3.4.5.(3) and Table 12.3.4.5.</td></tr>
<tr><td>Exercise 10-3</td><td>(d) 5 minutes

Code Ref.: Sentence 12.3.4.6.(5)</td></tr>
<tr><td>Exercise 10-4</td><td>(c) 43℃

Sentence 12.3.4.6.(6)</td></tr>
</table>

<table>
<tr><th>Exercise Number</th><th>Answer</th></tr>
<tr><td colspan="2">Module 11 Part 9 Non-Residential – Electric Motors</td></tr>
<tr><td>Exercise 11-1</td><td>No

Minimum efficiency rating of 90.2%

Code Ref.: Sentence 12.3.4.12.(1) references SB-10 Table 10.8, Column C.</td></tr>
<tr><td colspan="2">Module 12 Part 9 Non-Residential – Lighting</td></tr>
<tr><td>Exercise 12-1</td><td>
<table>
<tr><th>Lighting System Serving:</th><th>Complies</th><th>Does not Comply</th><th>Code Ref.</th></tr>
<tr><td>Loading dock serving a single storey 500 m^2 warehouse (without electric space heating)</td><td>✓</td><td></td><td>Clause 12.3.4.7.(1) (b)</td></tr>
<tr><td>Emergency lighting:</td><td></td><td>✓</td><td>Sentence 12.3.4.7.(2)</td></tr>
<tr><td>Exits in an apartment building</td><td></td><td>✓</td><td>(residential occupancy) Clause 12.3.4.7.(1) (b)</td></tr>
</table>
</td></tr>
<tr><td>Exercise 12-2</td><td>Interior lighting power allowance (PA)= 18 00W

Interior Power Allowance
=(2 x PA office x Area) + (PA post office x Area) + (PA retail x Area)
=(2 x 11 W/m^2 x 500m^2) + (12 W/m^2 x 250 m^2)+(16 W/m^2 x 250m^2) = =18,000 W or 18 kW

Code Ref.: Sentence 12.3.4.8.(2) and Table 12.3.4.8.</td></tr>
</table>

Exercise Number	Answer
Exercise 12-3	(a) 5,500 W Maximum interior lighting power allowance =floor area x Power allowance $=500\ m^2 \times 11\ W/m^2 = 5{,}500\ W$ Code Ref.: Sentence 12.3.4.8.(2) and Table 12.3.4.8.
Exercise 12-4	Answer: 2697 W Exterior lighting power allowance: the sum of the following: Drive up windows: 2 windows x 400W Parking: $600\ m^2 \times 1.6 W/m^2$ Main ent: 2 entrances x 98 W/m (assume 1 metre door width) Service ent: 1 entrance x 66W/m (assume 1 metre door width) Canopy: $50m^2 \times 13.5\ W/m^2$ Sum = 2697 W Code Ref.: Sentence 12.3.4.10.(3)
Exercise 12-5	Answer: 2832 W Maximum Exterior lighting power allowance is increasing the total power allowance by 5%. 2697 W x1.05= 2832W Code Ref.: Sentence 12.3.4.10.(3) and (4)
Exercise 12-6	(a) False Code Ref.: Sentence 12.3.4.9.(1) (b) False Code Ref.: Sentence 12.3.4.9.(3)
Exercise 12-7	(d) No control devices required in parking structures Code Ref.: Clause 12.3.4.11.(2)(b)

Exercise Number	Answer
Exercise12-8	(a) 1.25 Code Ref.: Sentence 12.3.4.7.(3). and Table 9.1.5.1 of SB-10

Module 13 All Buildings – Motion Sensors

Exercise 13-1

Area	Permitted	Not Permitted	Code Ref.
Classrooms:	✓		Sentence 12.2.2.1.(1)
Floor level in movie theatre:		✓	Clause 12.2.2.1.(1)(c) and Sentence 3.2.7.1.(5)
Hotel public corridor:	✓		Sentence 12.2.2.1.(2)
Nursing home supplementary lighting public corridor:	✓		Sentence 12.2.2.1.(1)
Service hallways:	✓		Sentence 12.2.2.1.(3)
Apartment stairwell:		✓	Clause 12.2.2.(1)(a)

Module 14 All Buildings – Water Efficiency

Exercise 14-1	(a) Yes. Flow rate of shower head is less than the maximum permitted flow rate Flow rate = L/min = Total flow/total time = 45L/5min = 9 L/min Table 7.6.4.1. permits a maximum flow rate of 9.5 L/min for shower heads. Code Ref.: Sentence 12.4.1.1.(1) and Sentence 7.6.4.1.(1) and Table 7.6.4.1.

Exercise Number	Answer
Exercise 14-2	(b) 3.8 Litres Automatic controls do not affect the flush cycle requirements. However they must be controlled to prevent unnecessary flushing during downtime. Code Ref.: Sentence 12.4.1.1.(1) and Sentence 7.6.4.2.(3) and Table 7.6.4.2.A
Exercise 14-3	(d) 13.25 Litres Although the fixture was installed post 1996. The actual system is constructed prior to 1996. Therefore, Table 7.6.4.2.A is applicable. Code Ref.: Sentence 12.4.1.1.(1) and Sentence 7.6.4.2.(2) and Table 7.6.4.2.A

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